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Meir

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(54) **INTERNAL UPS CARD FOR A COMPUTER**

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PCT Pub. Date: **Jun. 12, 1997**

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(51) **Int. Cl.**[7] **G06F 1/28**; G06F 11/07

(52) **U.S. Cl.** **713/300**; 714/14; 307/64; 307/66

(58) **Field of Search** 713/300, 340, 713/2; 714/14; 361/683, 752; 363/16, 37, 131; 323/215; 710/102, 126; 375/222; 307/64, 66, 85, 86, 150

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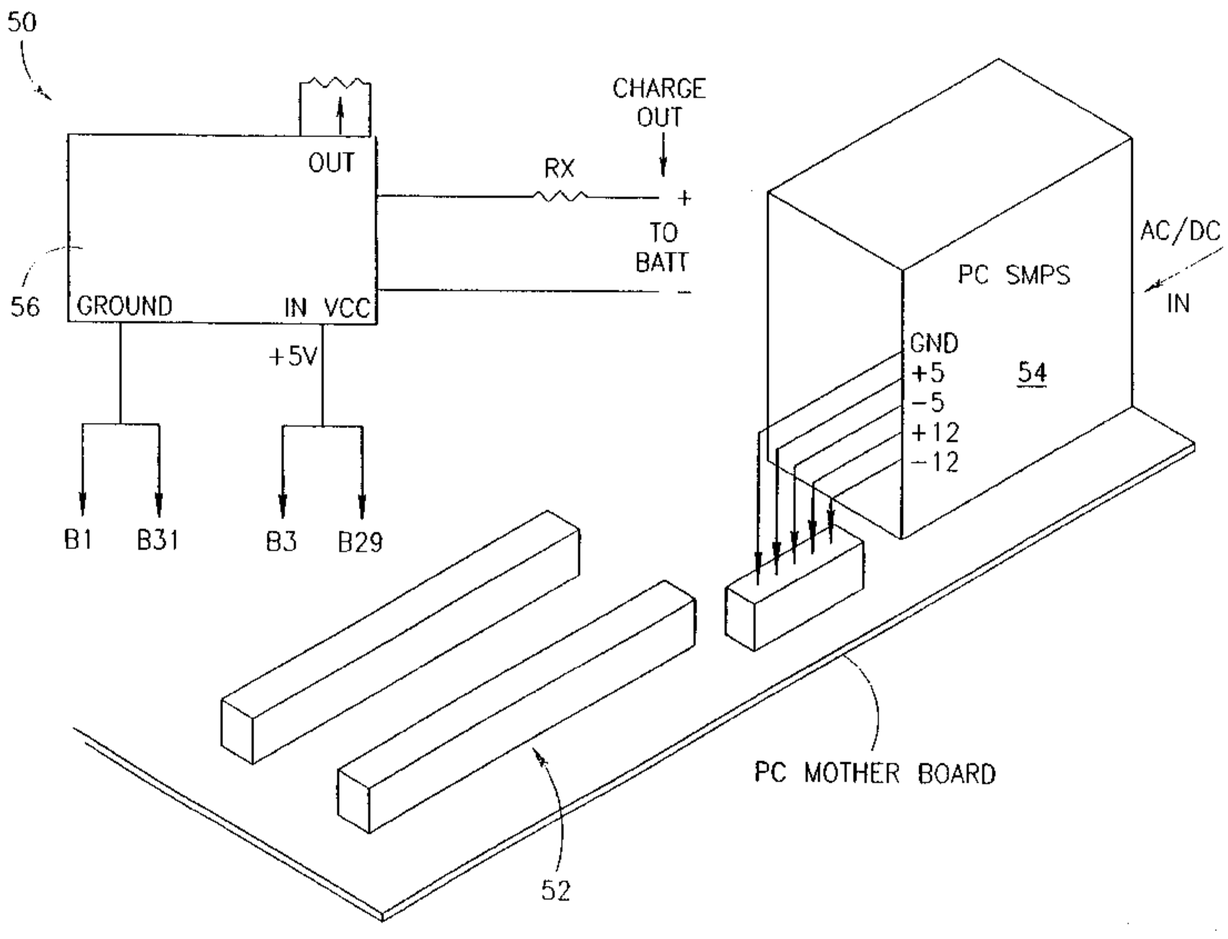
(57) **ABSTRACT**

An uninterrupted power supply (UPS) for a computer having a data storage element and an associated monitor, the computer operating on power supplied by an internal switch mode power supply (SMPS) system receiving line power, characterized in that the UPS comprises an internal device for installation inside the computer and the internal device supplies back up power and protection to the computer and to the monitor from power abnormalities and noises.

29 Claims, 18 Drawing Sheets



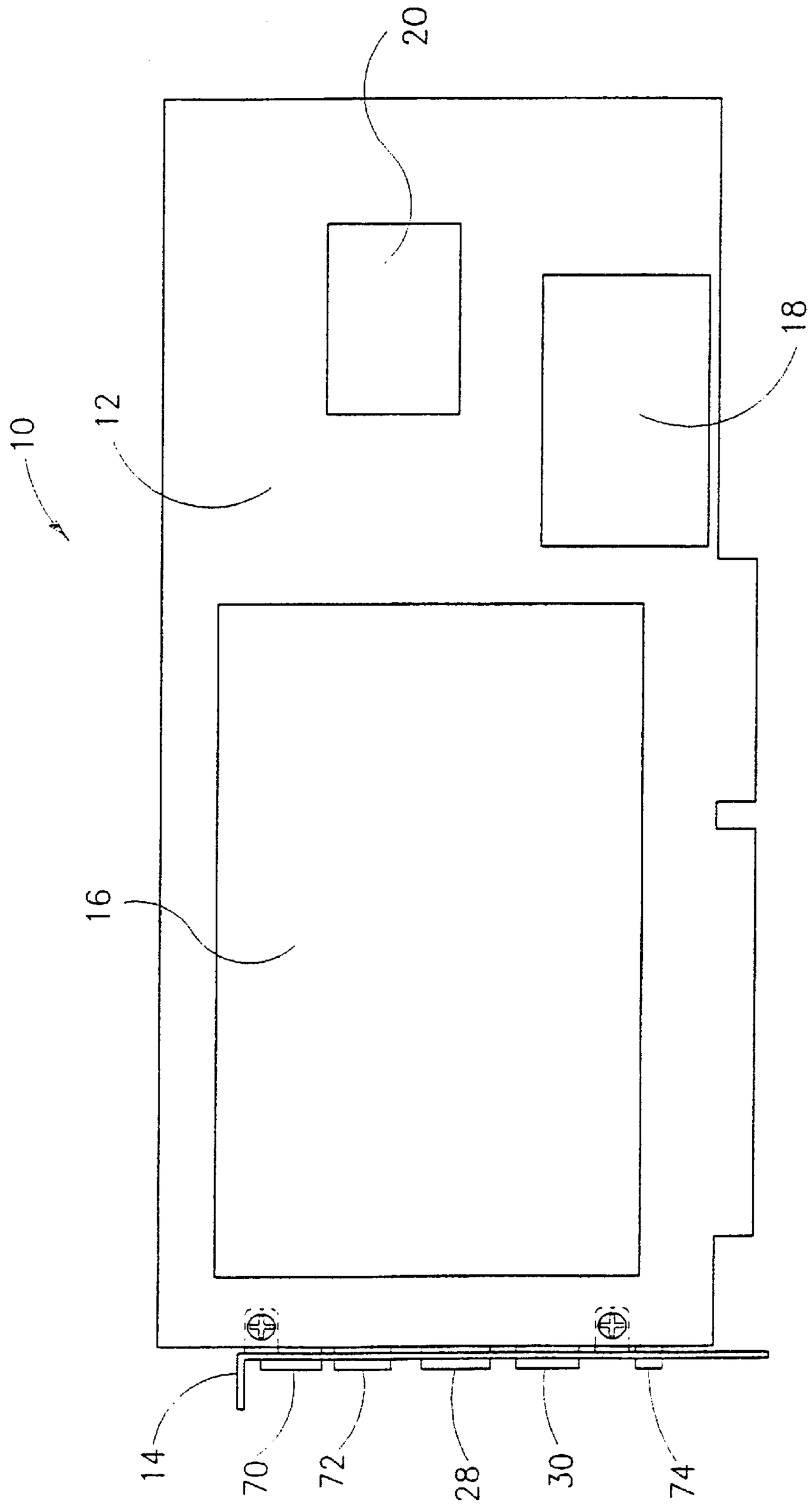


FIG. 1

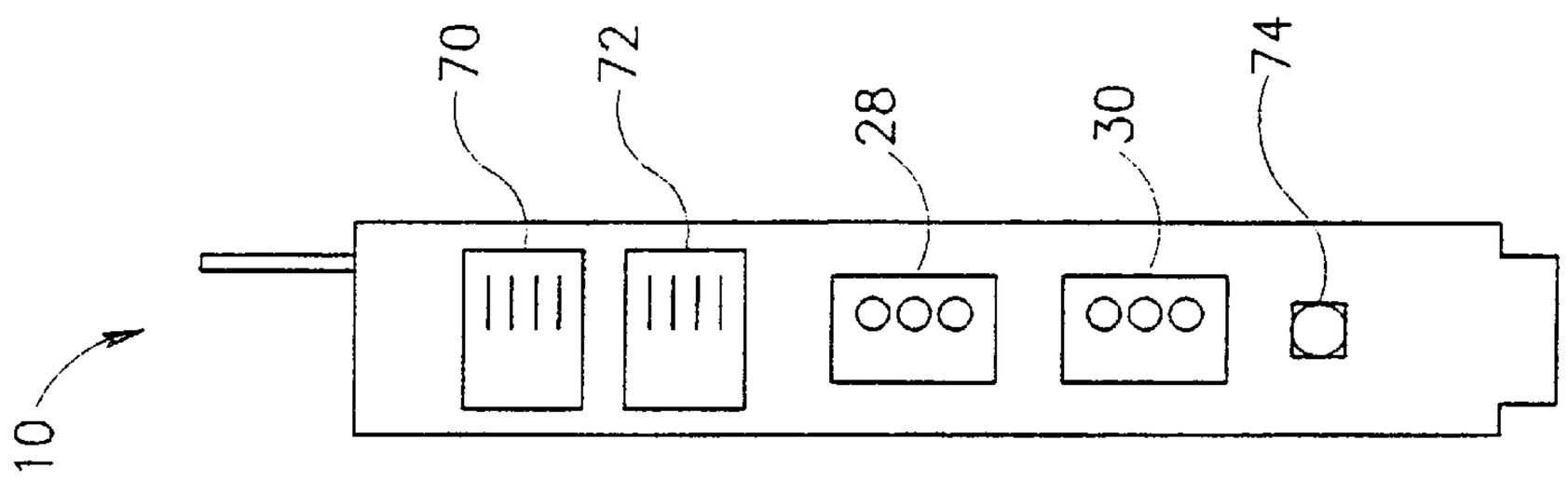


FIG.2B

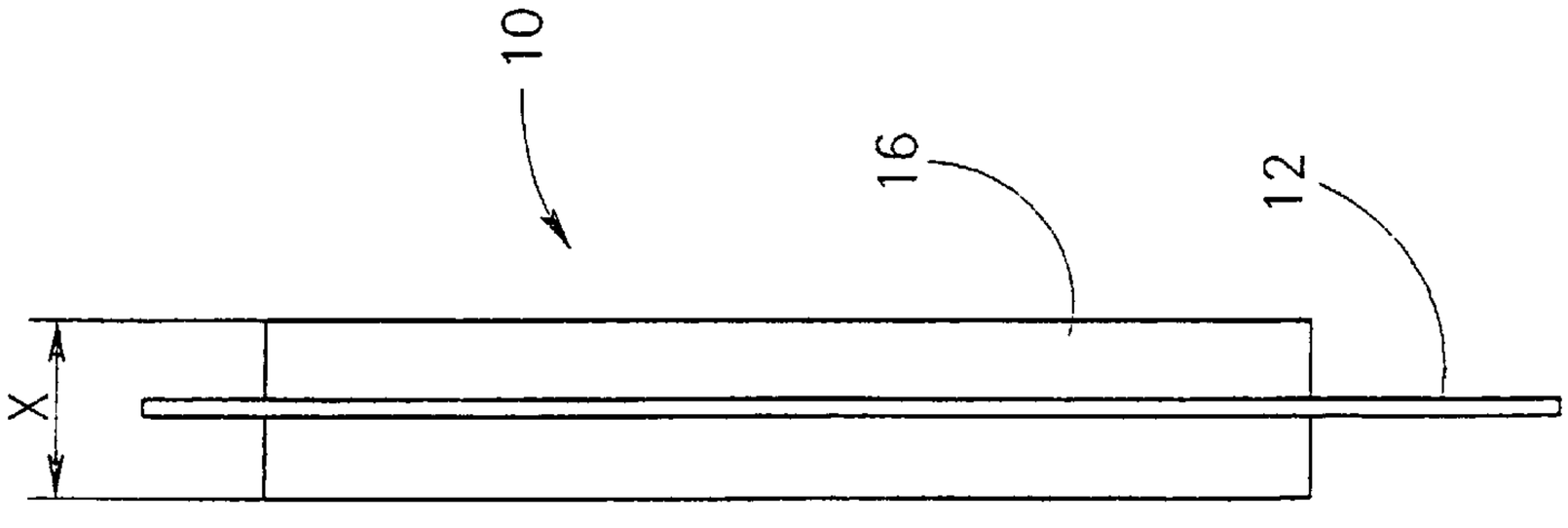


FIG.2A

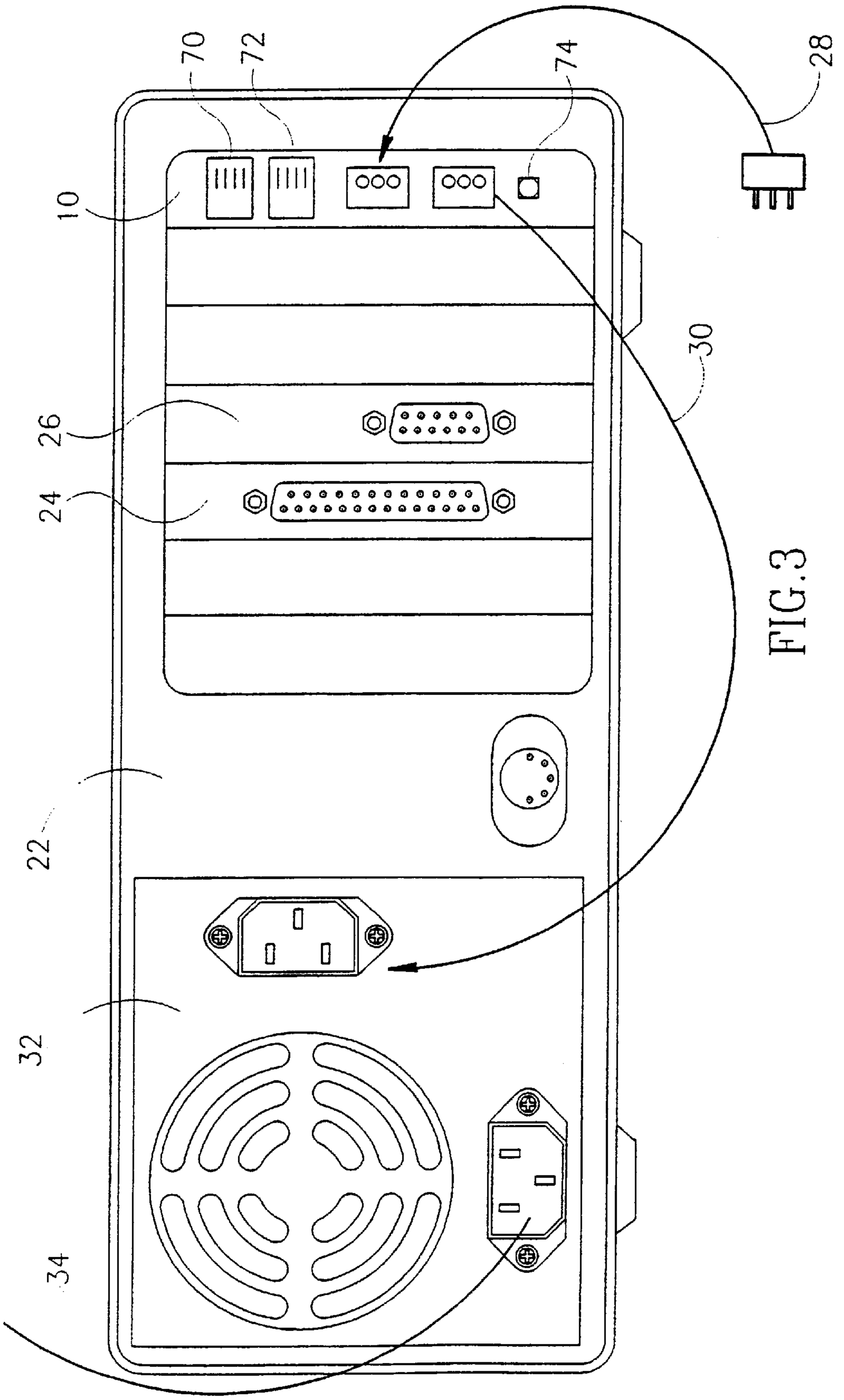


FIG.3

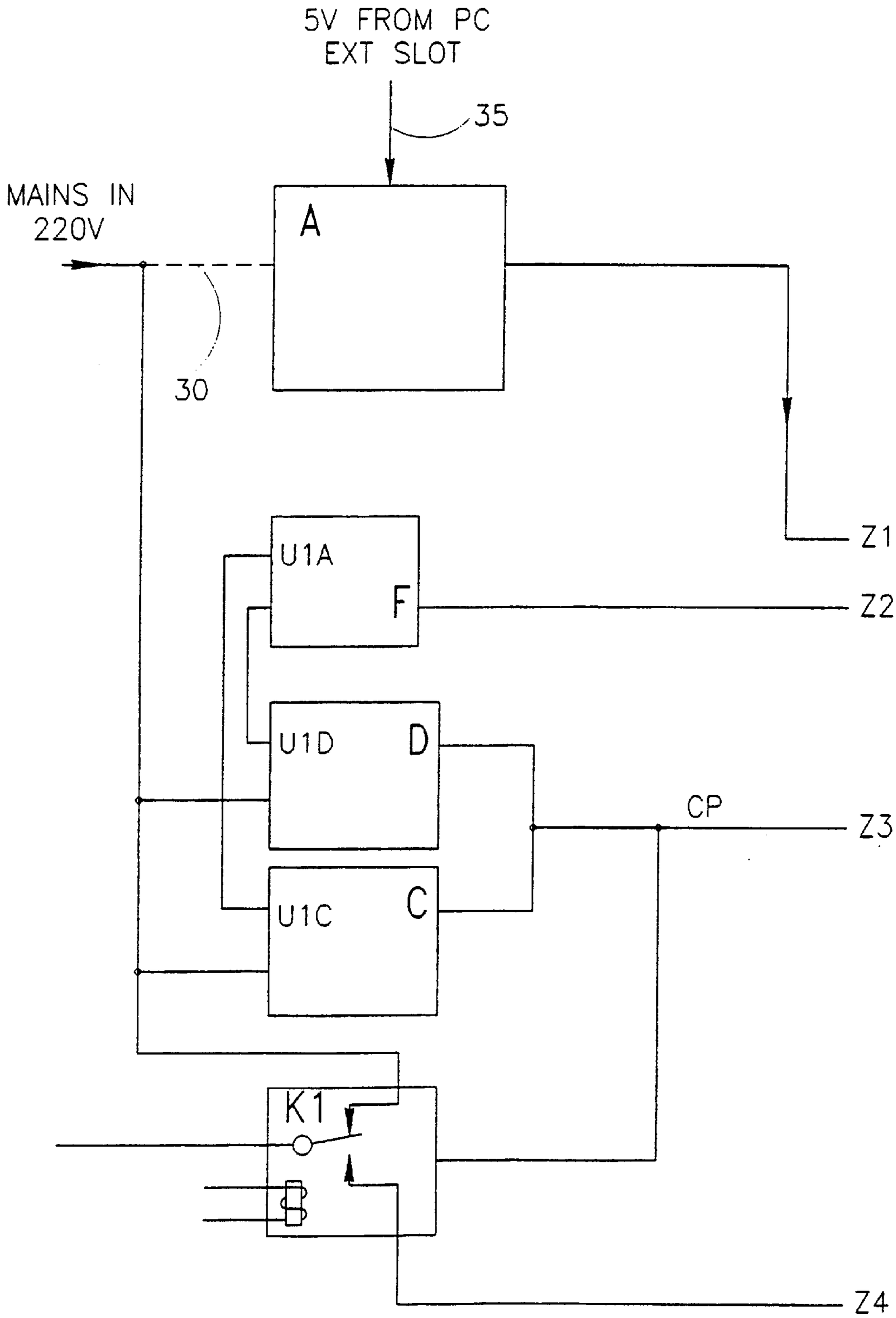

5V FROM PC
EXT SLOT
35
MAINS IN
220V
A
30
Z1
U1A
F
Z2
U1D
D
CP
Z3
U1C
C
K1
Z4

FIG.4A

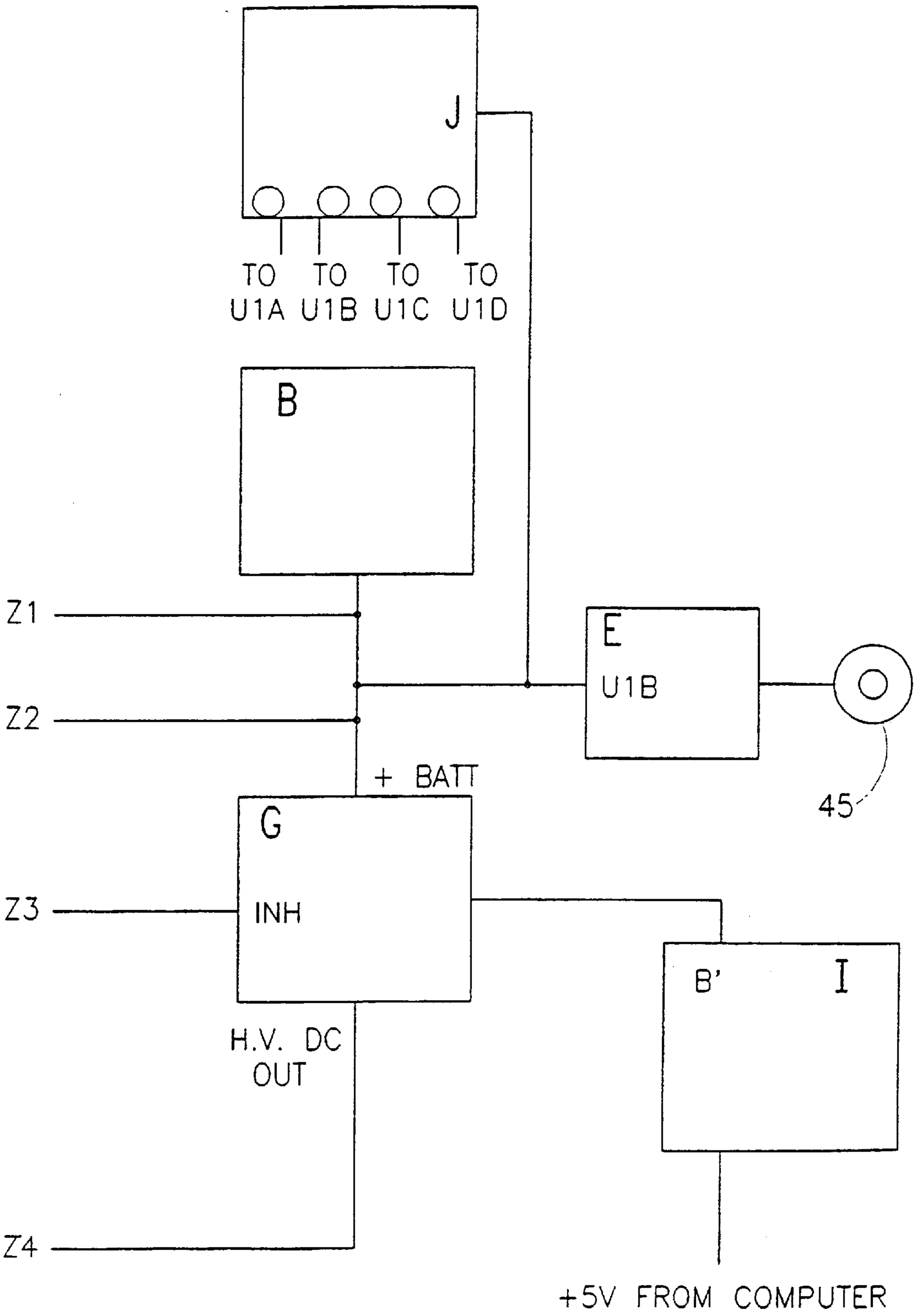

J
TO U1A
TO U1B
TO U1C
TO U1D
B
Z1
Z2
E
U1B
45
+ BATT
G
Z3
INH
B'
I
H.V. DC OUT
Z4
+5V FROM COMPUTER

FIG.4B

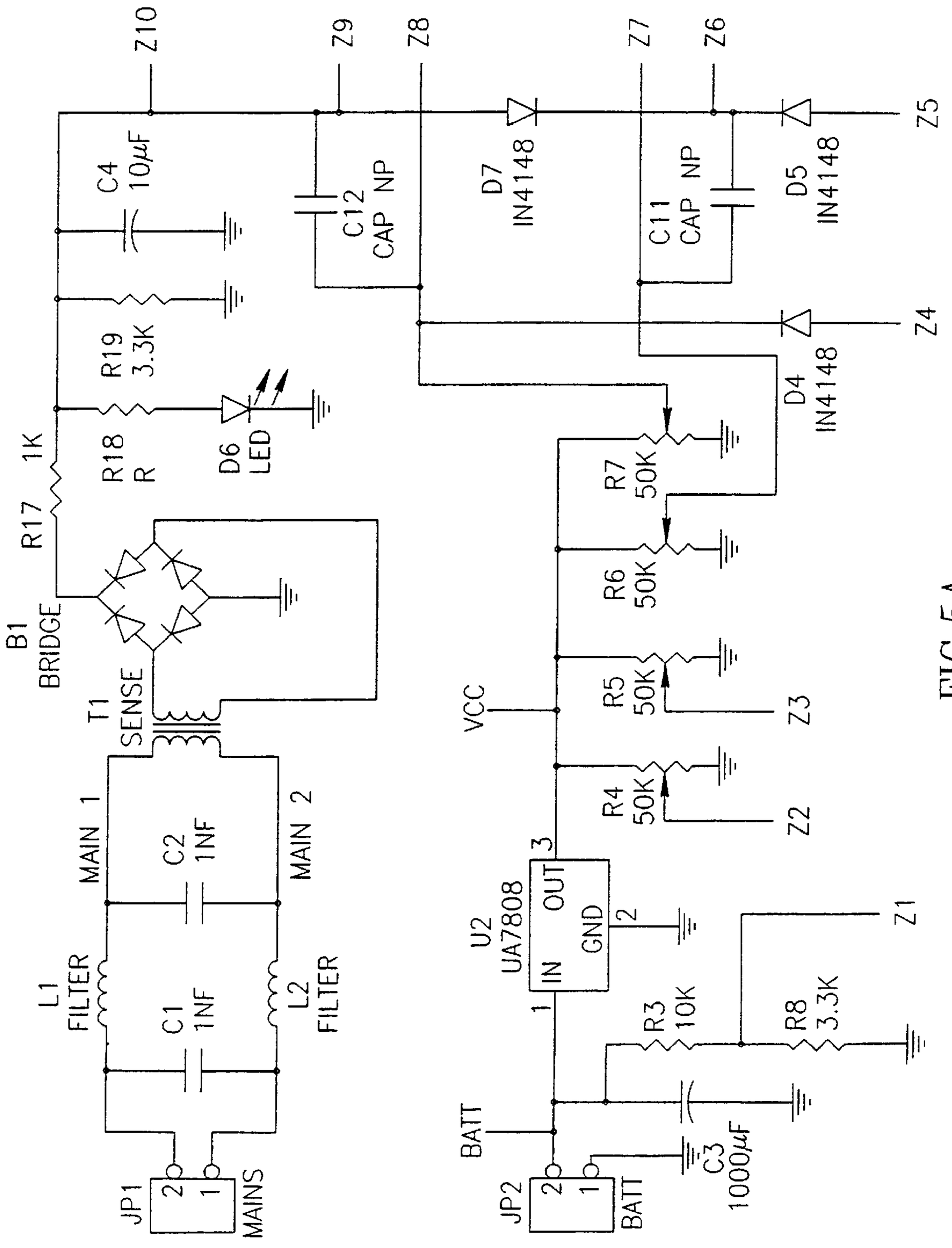

Z10
Z9
Z8
Z7
Z6
Z5
Z4
C4
10μF
C12
CAP NP
D7
IN4148
C11
CAP NP
D5
IN4148
D4
IN4148
R19
3.3K
R18
R
D6
LED
R17
1K
R7
50K
R6
50K
R5
50K
R4
50K
R1
B1
BRIDGE
T1
SENSE
VCC
MAIN 1
MAIN 2
C2
1NF
L1
FILTER
L2
FILTER
C1
1NF
U2
UA7808
IN
OUT
GND
3
2
1
Z3
Z2
Z1
R3
10K
R8
3.3K
BATT
C3
1000μF
JP1
2
1
MAINS
JP2
2
1
BATT

FIG.5A

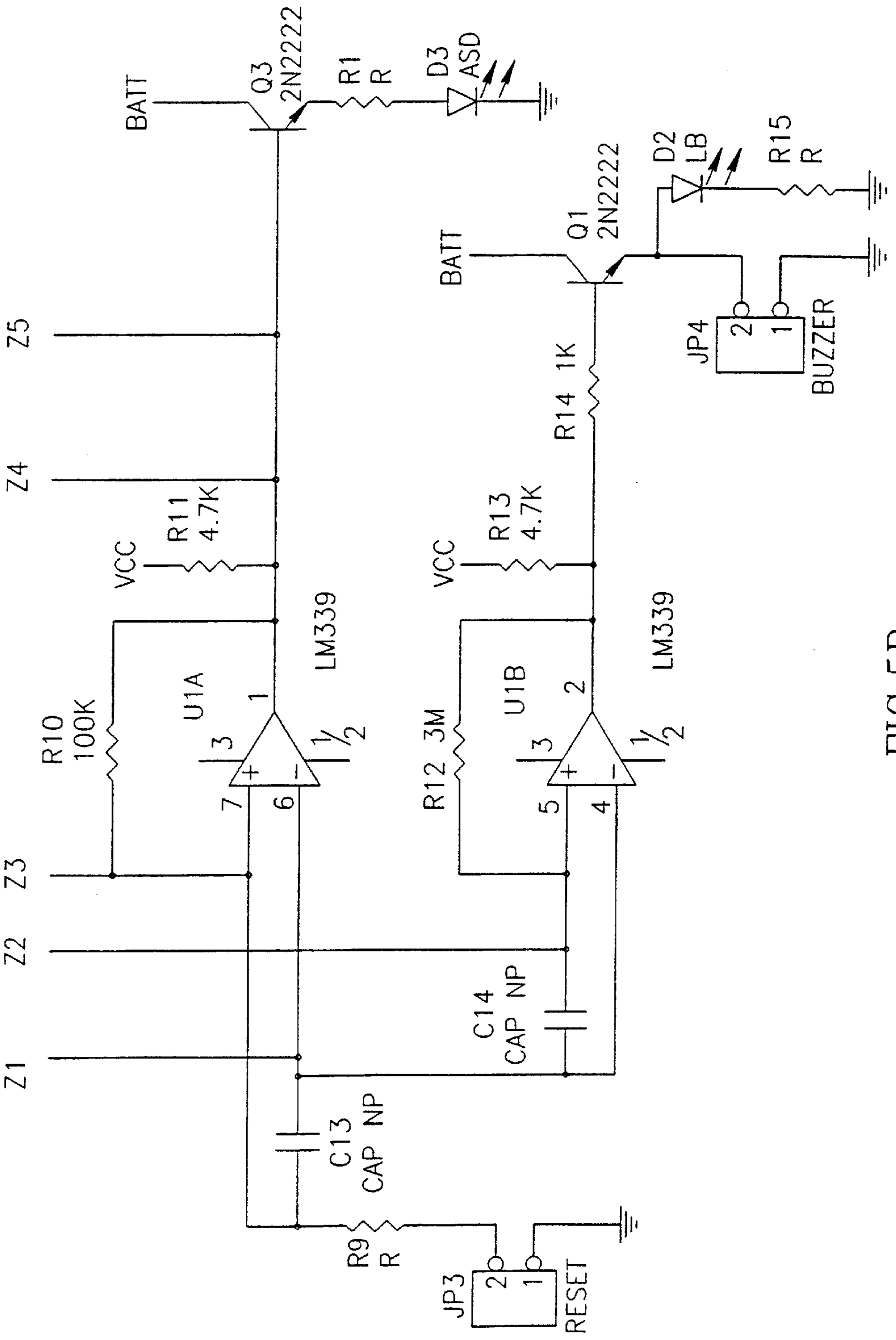

BATT
Q3
2N2222
R1
R
D3
ASD
D2
LB
R15
R
Q1
2N2222
BATT
JP4
2
1
BUZZER
Z5
Z4
VCC
R11
4.7K
R14 1K
VCC
R13
4.7K
LM339
R10
100K
U1A
3
1
7
6
1/2
R12 3M
U1B
2
3
5
4
1/2
LM339
Z3
Z2
Z1
C14
CAP NP
C13
CAP NP
R9
R
JP3
2
1
RESET

FIG.5B

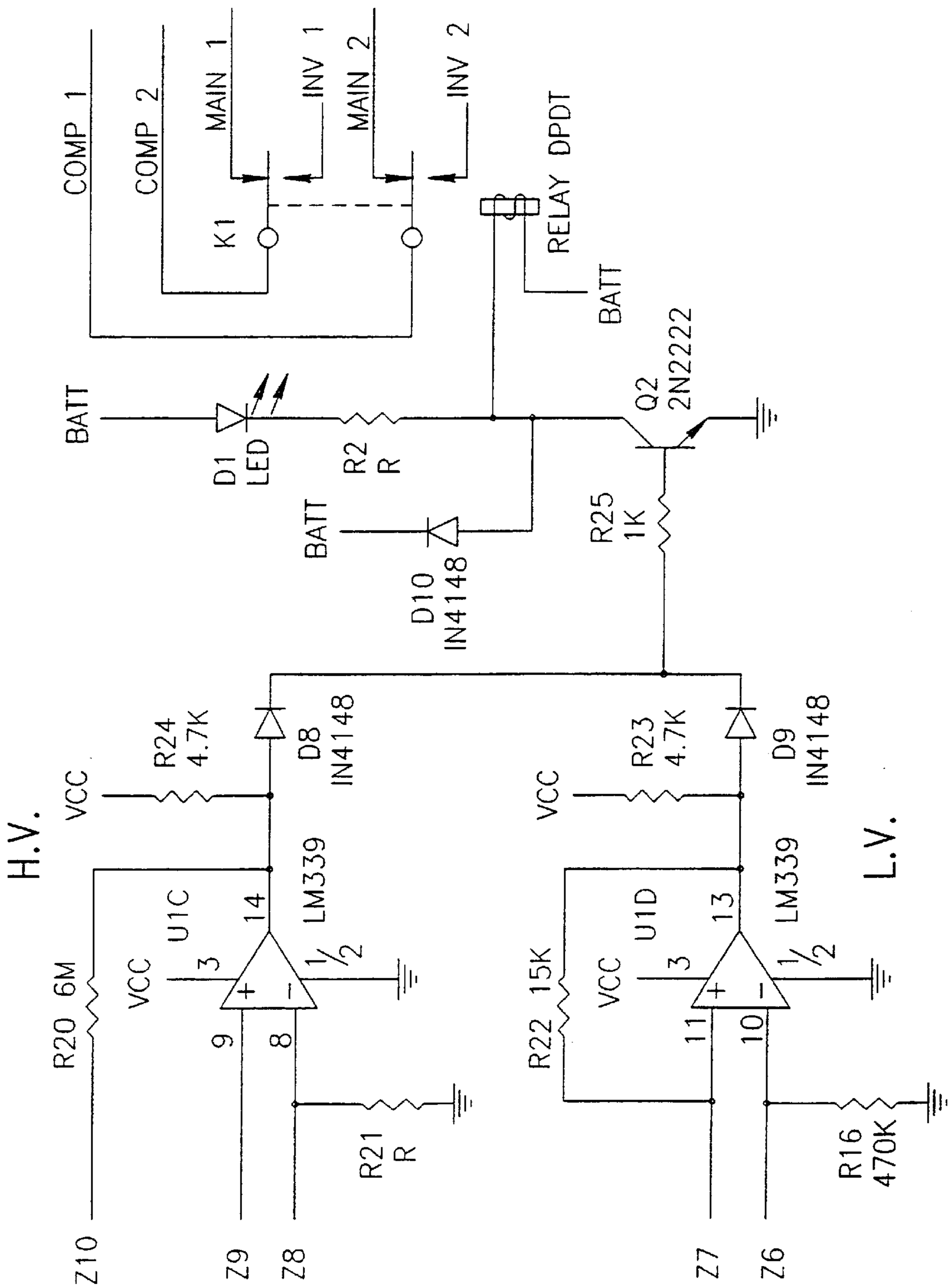

COMP 1
COMP 2
MAIN 1
INV 1
MAIN 2
INV 2
RELAY DPDT
K1
BATT
D1
LED
R2
R
Q2
2N2222
D10
IN4148
R25
1K
H.V.
VCC
R24
4.7K
D8
IN4148
U1C
LM339
1/2
R20 6M
R21
R
L.V.
R23
4.7K
D9
IN4148
U1D
R22 15K
R16
470K
Z10
Z9
Z8
Z7
Z6

FIG.5C

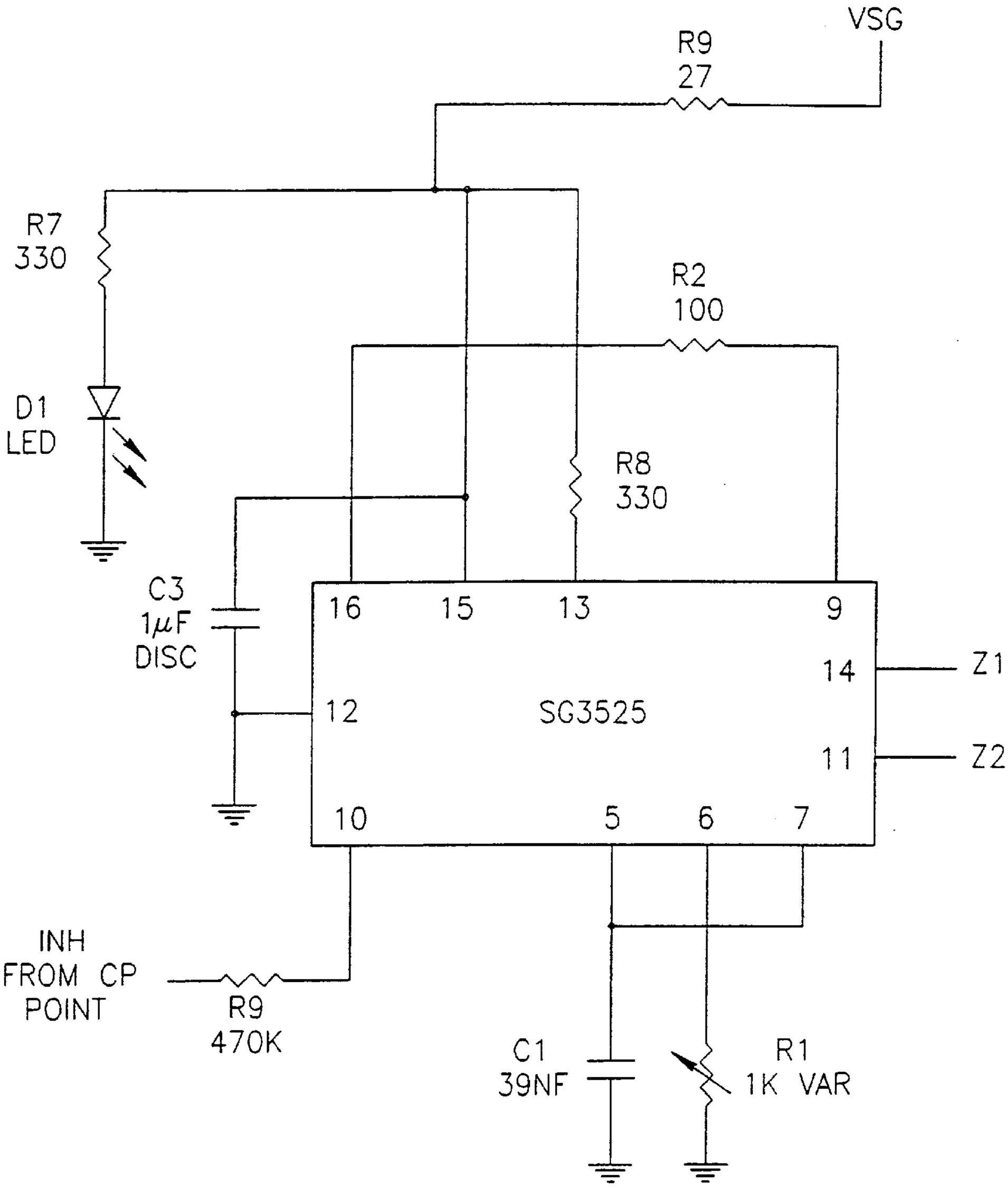

VSG
R9
27
R7
330
R2
100
D1
LED
R8
330
C3
1μF
DISC
16
15
13
9
14
Z1
12
SG3525
11
Z2
10
5
6
7
INH
FROM CP
POINT
R9
470K
C1
39NF
R1
1K VAR

FIG.6A

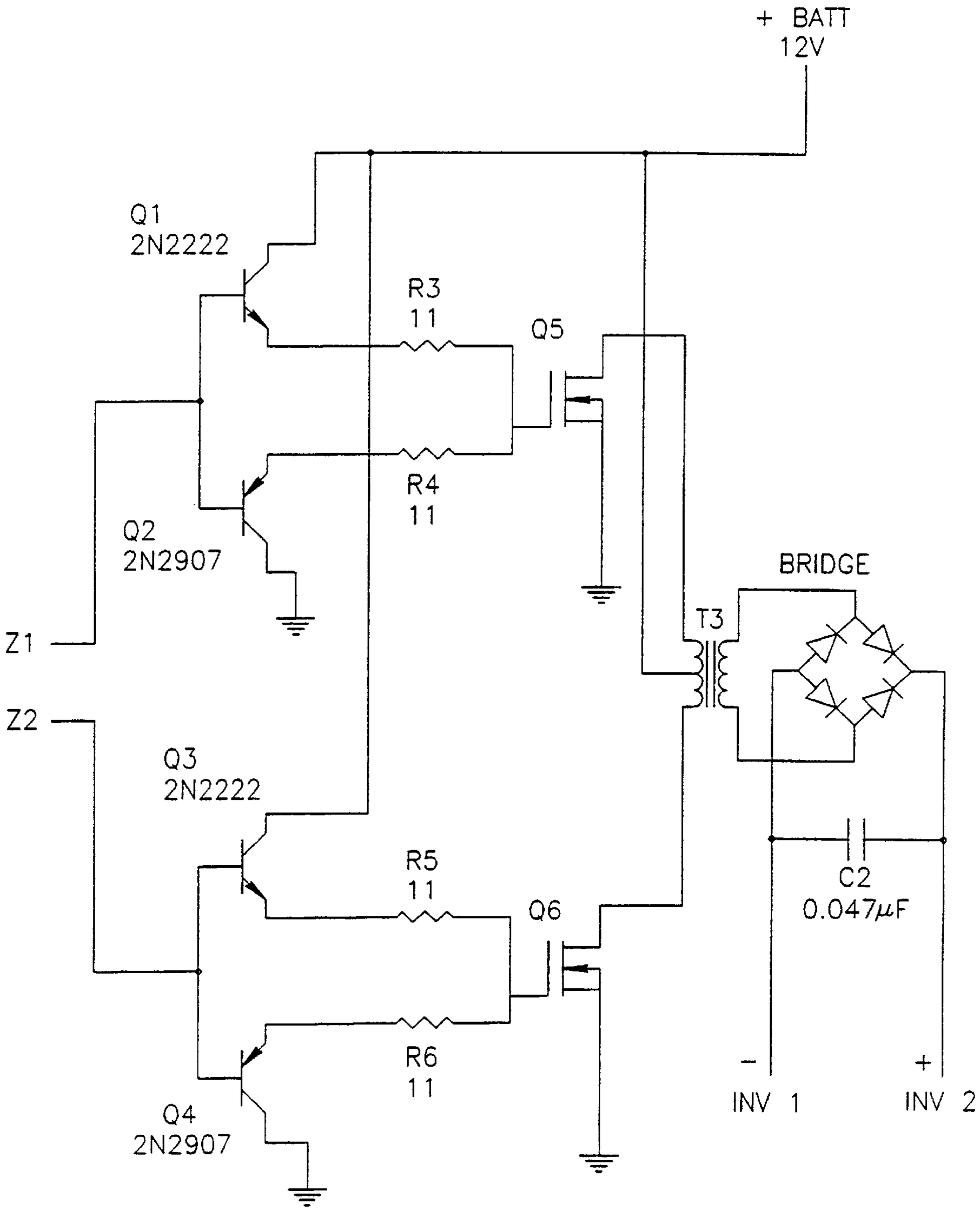

+ BATT
12V
Q1
2N2222
R3
11
Q5
R4
11
Q2
2N2907
Z1
Z2
Q3
2N2222
R5
11
Q6
R6
11
Q4
2N2907
BRIDGE
T3
C2
0.047μF
–
+
INV 1
INV 2

FIG.6B

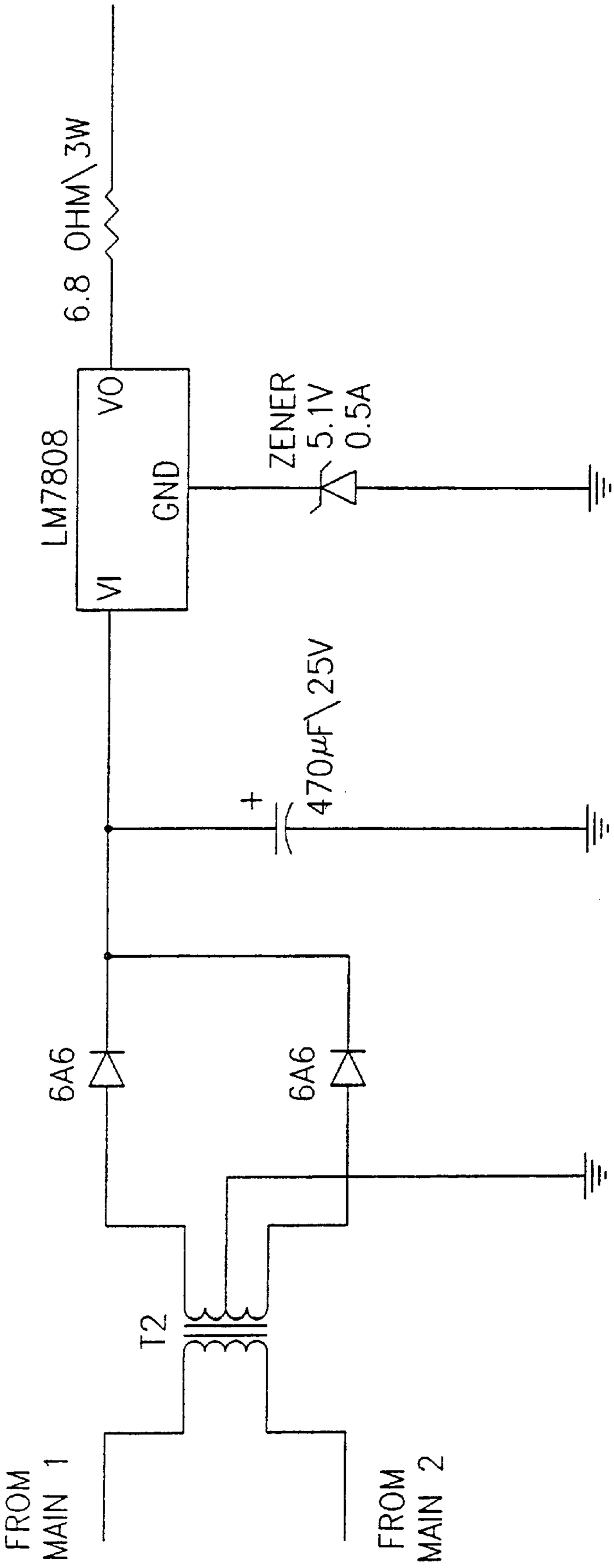

FROM MAIN 1
FROM MAIN 2
T
2
6A6
6A6
+
470μF\25V
LM7808
VI
GND
VO
6.8 OHM\3W
ZENER 5.1V 0.5A

FIG. 17

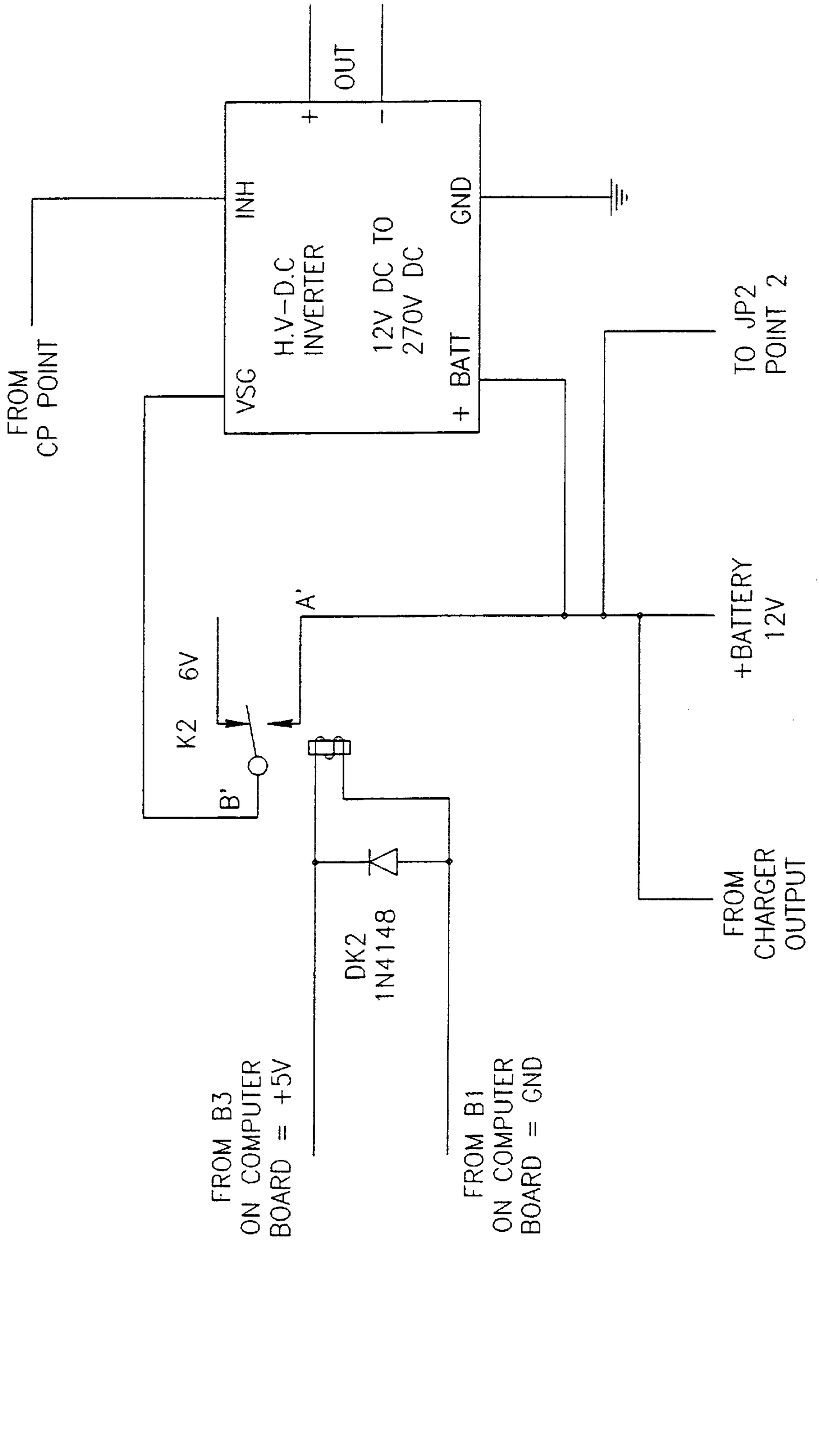

OUT
+
-
INH
VSG
H.V-D.C
INVERTER
12V DC TO
270V DC
GND
+ BATT
FROM
CP POINT
TO JP2
POINT 2
A'
K2 6V
B'
+BATTERY
12V
DK2
1N4148
FROM
CHARGER
OUTPUT
FROM B3
ON COMPUTER
BOARD = +5V
FROM B1
ON COMPUTER
BOARD = GND

FIG. 8

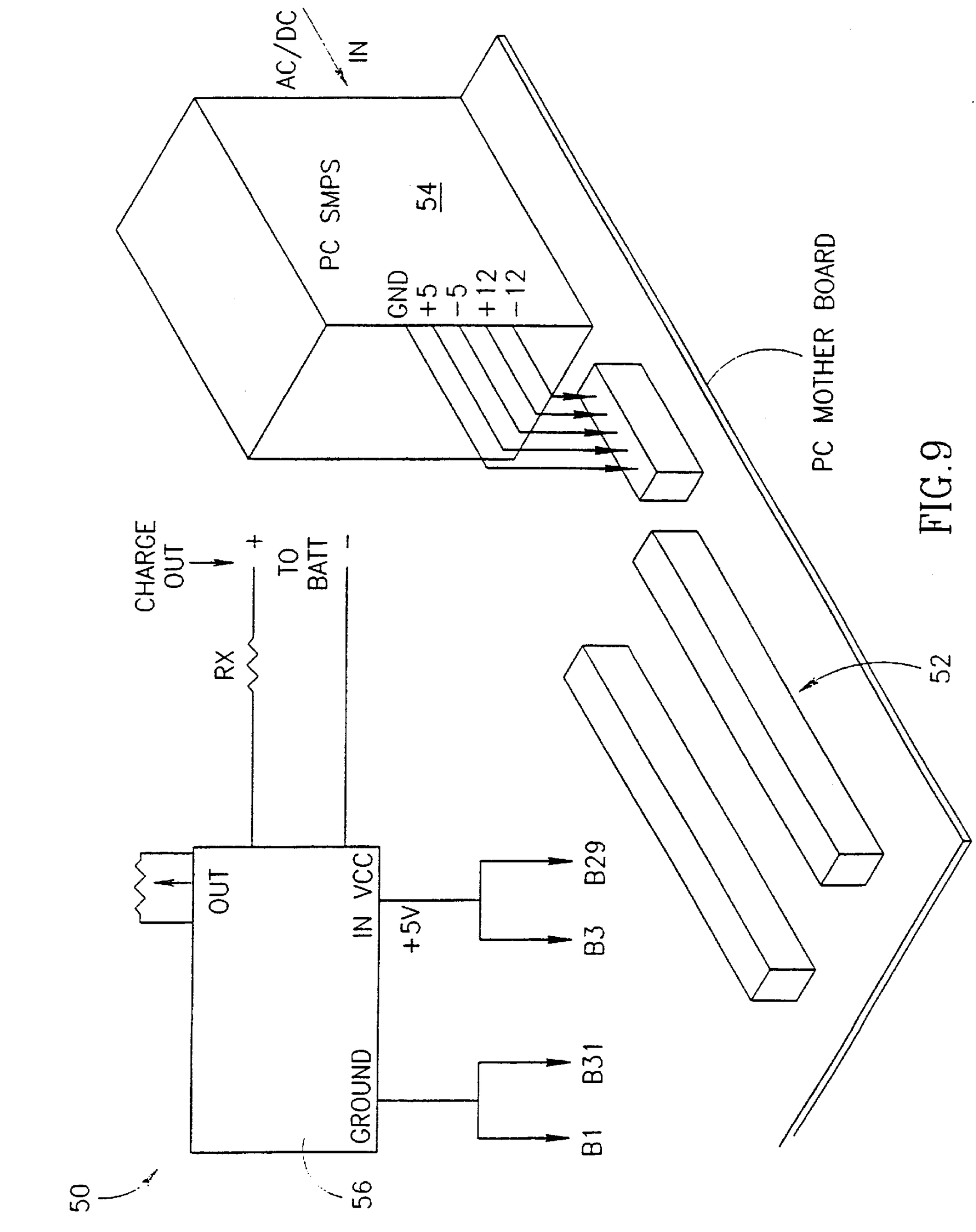

AC/DC IN
PC SMPS
54
GND
+5
-5
+12
-12
PC MOTHER BOARD
52
CHARGE OUT
+
TO BATT
-
RX
OUT
IN VCC
+5V
B3 B29
GROUND
B1 B31
50
56

FIG.9

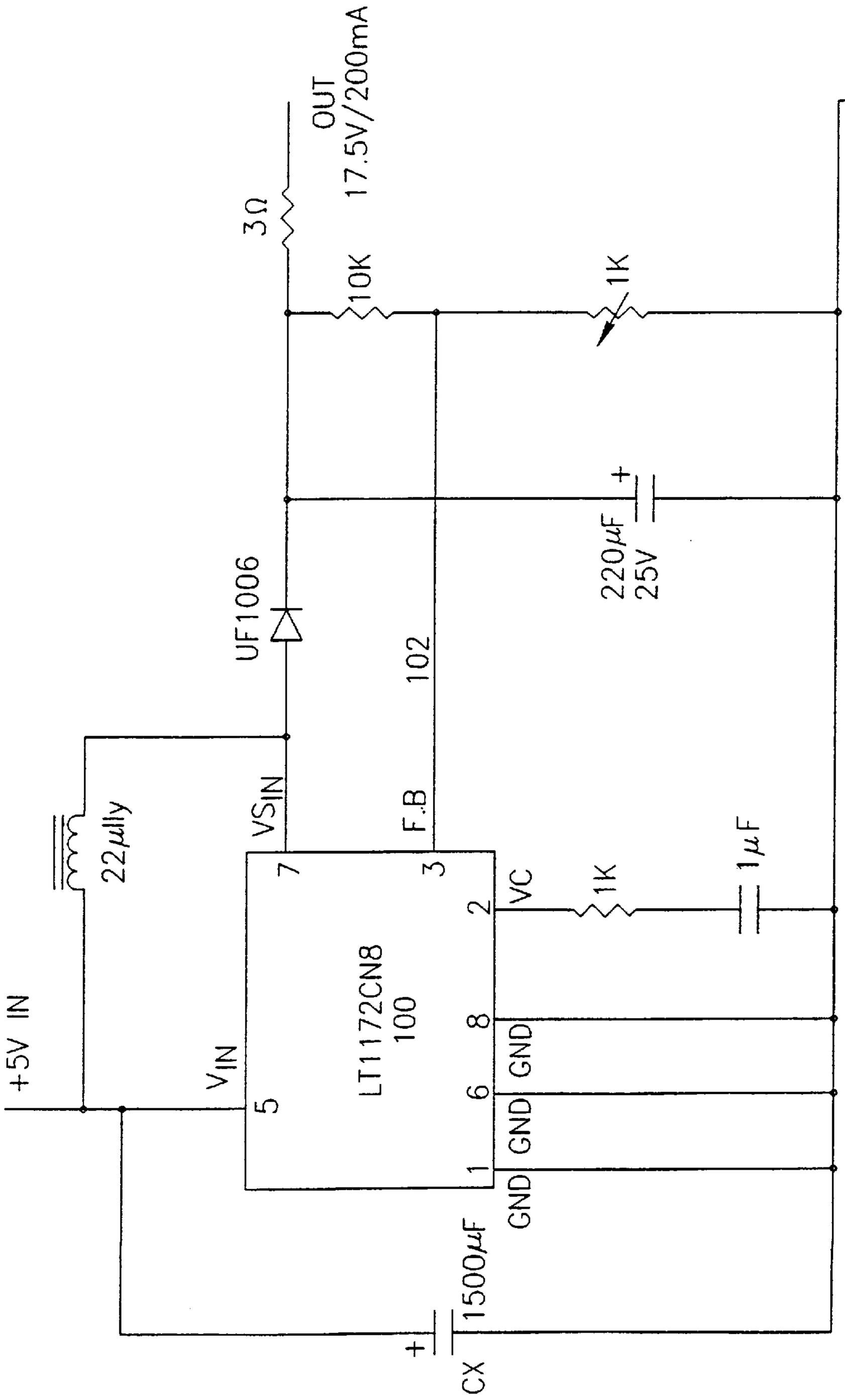

3Ω
OUT
17.5V/200mA
10K
1K
220μF
25V
UF1006
102
22μHy
+5V IN
VSIN
F.B
VIN
7
3
5
LT1172CN8
100
2
VC
1K
1μF
8
GND
6
GND
1
GND
CX
1500μF
GND

FIG. 10

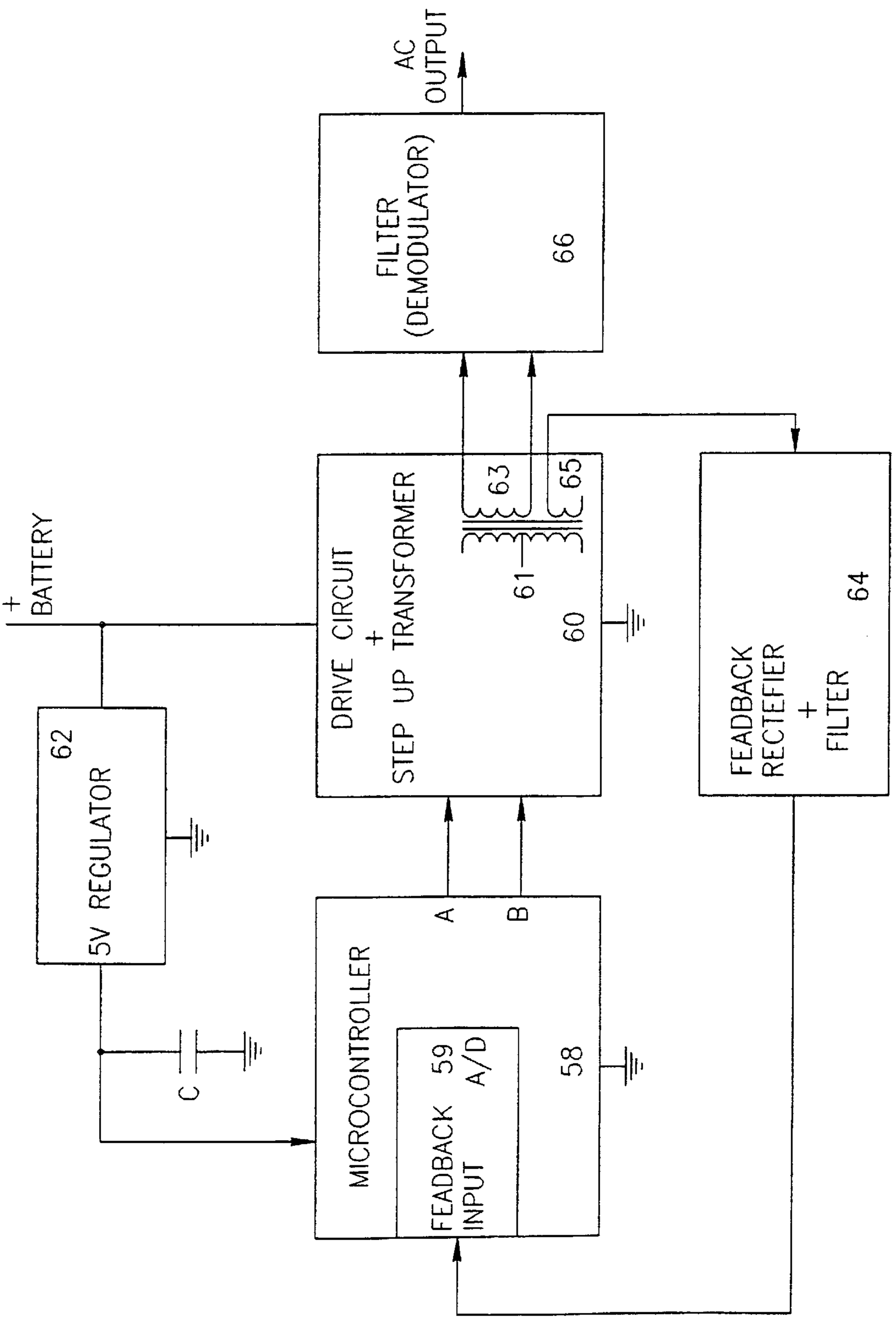

AC OUTPUT
FILTER (DEMODULATOR) 66
DRIVE CIRCUIT + STEP UP TRANSFORMER
63
65
61
60
64
FEADBACK RECTEFIER + FILTER
+ BATTERY
62 5V REGULATOR
C
MICROCONTROLLER
FEADBACK INPUT 59 A/D
58
A
B

FIG. 11

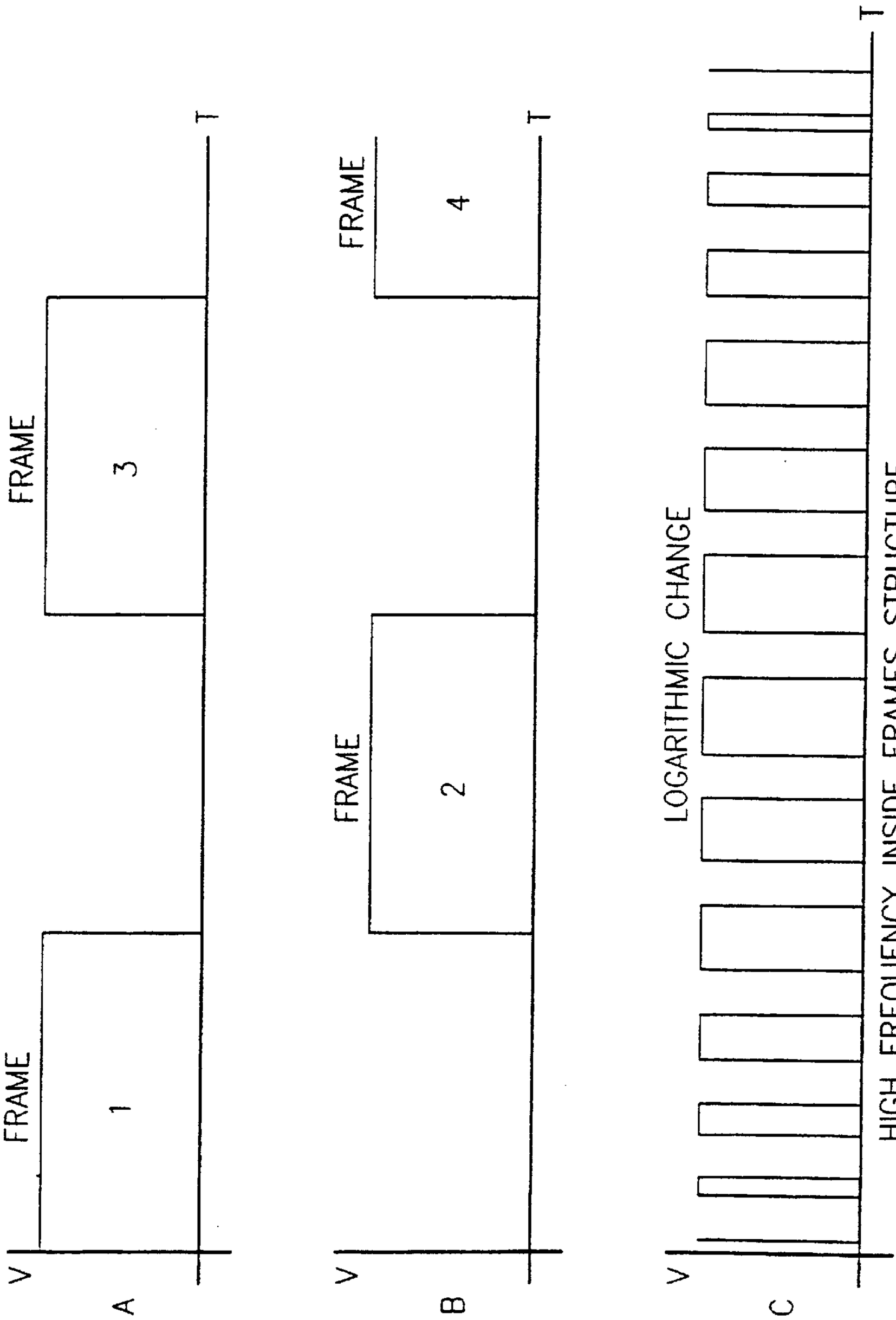

FRAME
3
FRAME
4
FRAME
2
FRAME
1
LOGARITHMIC CHANGE
STRUCTURE
HIGH FREQUENCY INSIDE FRAMES
V
A
V
B
V
C

FIG.12

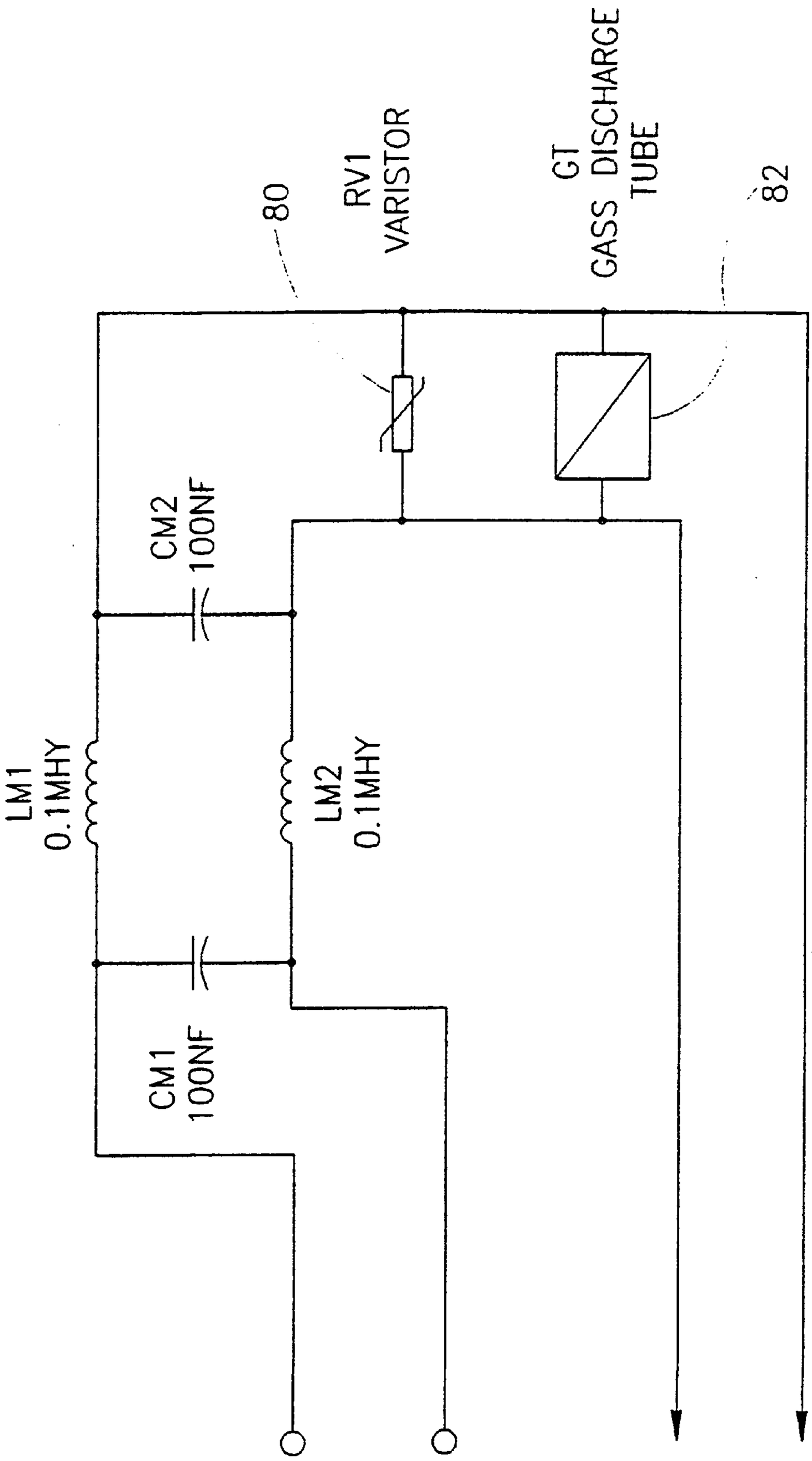

80
RV1
VARISTOR
GT
GASS DISCHARGE
TUBE
82
CM2
100NF
LM1
0.1MHY
LM2
0.1MHY
CM1
100NF

FIG.13

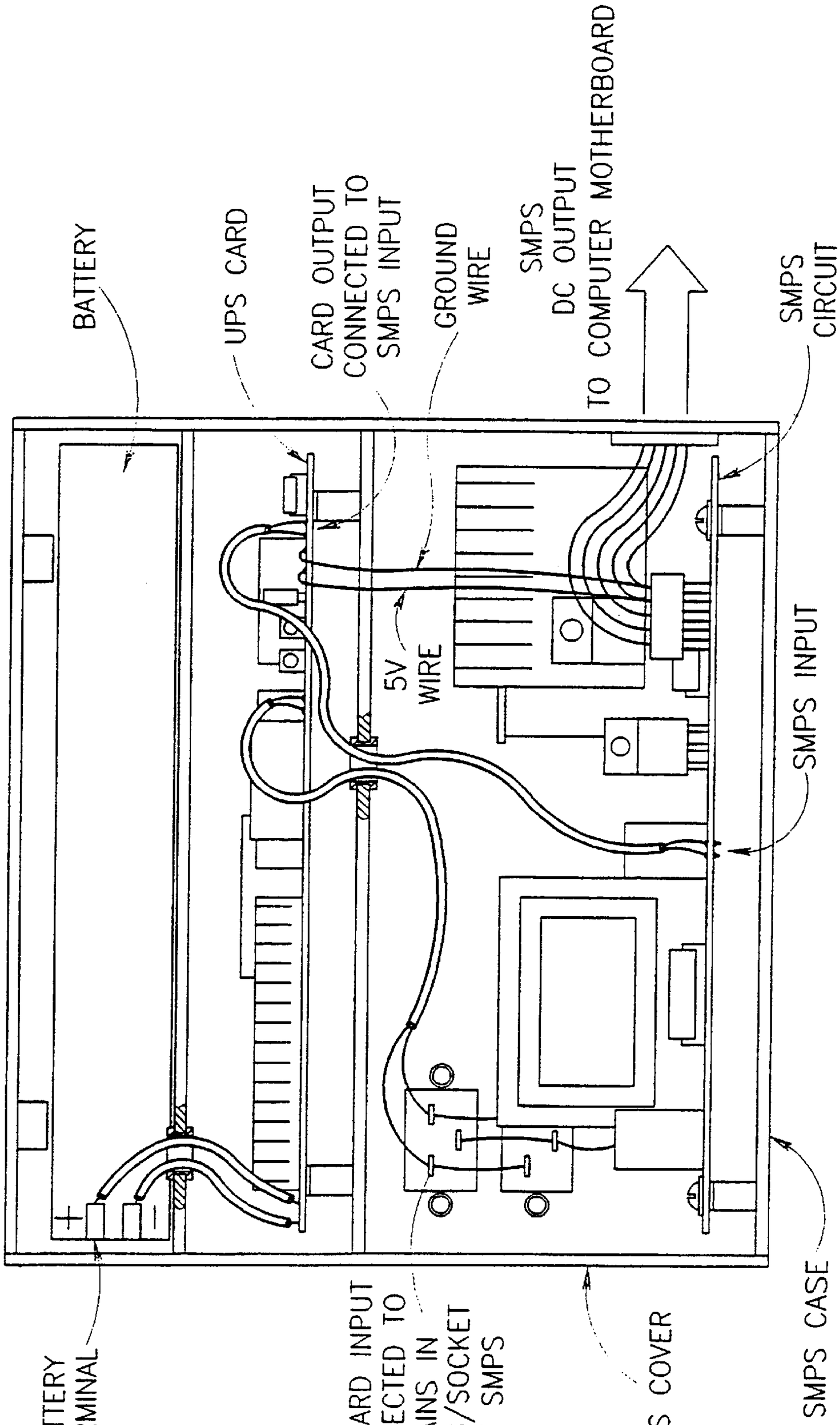

BATTERY
UPS CARD
CARD OUTPUT CONNECTED TO SMPS INPUT
GROUND WIRE
SMPS DC OUTPUT TO COMPUTER MOTHERBOARD
SMPS CIRCUIT
5V WIRE
SMPS INPUT
+
-
BATTERY TERMINAL
UPS CARD INPUT CONNECTED TO MAINS IN PLUG/SOCKET OF SMPS
SMPS COVER
SMPS CASE

FIG. 14

INTERNAL UPS CARD FOR A COMPUTER

BACKGROUND OF THE INVENTION

Modern personal computers (PC) are increasingly used in companies, offices and by private users. Their failure or malfunction may cause severe and costly damage or expensive loss of data and information. Unfortunately, the quality of utility power does not guaranty reliable operation of personal computers. Outages, abnormal voltage and transients disturb or halt the operation, erase precious data and cause deterioration of components and hardware failures.

SUMMARY OF THE INVENTION

The present invention relating to an internal UPS card is designed to supply power to personal computers and monitors, such as super VGA color screens, and protect the computer and screen against all power disruptions including outages. This card is installed inside the computer, for example, in the conventional bus slots and requires only one or two bus slots, and has the power to back up both the computer and the monitor or screen. This is made possible by using a very small inverter that inverts for example a 12 V slim battery (about 20 mm) to high DC or AC voltage, typically 280 V, for DC or 220/110 V for AC, with high efficiency. The inverter functions at high frequency, 15 to 200 KHz, preferably about 25 KHz, and very high efficiency. This is achieved by using a low profile planar transformer such as a ferrite transformer and Mosfet transistors with very low Rds ON. The high-frequency step-up voltage from the output of the planar transformer is rectified by ultra fast or fast diodes. In this way we get a DC voltage output that can operate computers and monitors or screens. Similarly, an AC inverter with planar transformer can produce a high AC voltage. The computers and screens can function directly from the DC or AC power generated.

The UPS card of this invention preferably does not have a power switch of its own, but is turned on and off by the PC power switch, together with the computer. In this way it is easy to power up the card and simplifies to a minimum its installation, which takes less than 2 minutes with proper instruction. However, it is possible for the UPS to be activated by an independent on/off switch which may be located on the UPS card bracket.

The card can also be installed inside the PC power supply (SMPS) with little change of size and wiring.

The invention will be better understood with reference to the following drawings in which:

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a schematic plan view of a UPS card constructed in accordance with one embodiment of the invention;

FIG. **2***a* is a rear end view of the UPS card of FIG. **1**;

FIG. **2***b* is a front end view of the UPS card of FIG. **1**;

FIG. **3** is a schematic rear view of the illustration of a computer in which one embodiment of the UPS card of the present invention is installed;

FIGS. **4**A–**4**B are a block diagram of a UPS card in accordance with the invention;

FIGS. **5**A–**5**C are schematic diagrams of an electronic circuit including low/high voltage detector and low battery alarm means;

FIGS. **6**A–**6**B represent a schematic diagram of the inverter of the invention;

FIG. **7** is a circuit diagram of an automatic charger from main line in accordance with the invention; and

FIG. **8** is a conditional electronic circuit for operating the UPS card;

FIG. **9** is a schematic illustration of an alternative battery charger system for use with the UPS card of the invention; and

FIG. **10** is a circuit diagram of the battery charger of FIG. **9**.

FIG. **11** is a block diagram of a DC to AC inverter in accordance with the invention;

FIG. **12** illustrates the output wave forms generated by the microcontroller of FIG. **11**;

FIG. **13** is a circuit of an RFI/EMI filter with surge protection with reference to RJ**1** and RJ**2** of FIG. **2***b*.

FIG. **14** is a schematic diagram of a UPS enclosed in the PC-SMPS.

DETAILED DESCRIPTION OF THE INVENTION

The invention relates to an uninterruptible power system (UPS) in the form of an internal card and more particularly to an internal card type UPS which can ensure that no data will be lost when power interruption occurs. The card provides backup power to the PC and to the screen so that they remain on and allow the user to save data on a data storage element, such as on a hard disc, and turn off the computer safely.

The internal card type UPS of this invention is particularly useful inside a computer having a data storage element, such as a hard or floppy disc and optionally other hardware such as an internal or external modem/fax and SVGA screen or other monitor. The computer receives DC voltage from an internal switch mode power supply (SMPS) system receiving line power. The internal card provides backup power when line power is disrupted or abnormal. The UPS card has a built-in battery and charger for charging said battery when the line power is available. The card also has means for actuating a DC to DC or DC to AC high voltage inverter that oscillates at a high frequency. The DC to DC inverter provides, after rectification, high DC voltage output to operate said computer and screen, when line power is out side the normal, desired range (normal=say 220 V or 110 V±x %).

The inverter typically uses a low profile transformer, typically a planar or regular ferrite, transformer which is small and can be placed on a printed circuit board, so the card type UPS is thin and can be installed in one PC slot, or can be installed inside the computer power supply (SMPS), by changing the PCB layout and size. The card can also short out 2 points when the main line is off or abnormal on the RS232 connector via a small jumper cable, and together with software can order server/stand alone computer to close files and down-load the server/stand alone and communication between the server and other computers. The internal UPS card of this invention can also be adapted not to need an external jumper cable.

Referring now to FIGS. **1**, **2***a* and **2***b*, there is shown schematically a UPS card **10** constructed and operative in accordance with one embodiment of the invention in respective plan, rear end and front end views. Card **10** includes among other things a printed circuit board **12** affixed to a metal plate **14** with connectors, as known, for insertion into a slot in a computer. Card **10** includes a battery **16**, a planar transformer **18** and a battery charger **20**.

It is one particular feature of the invention that UPS card **10** is narrow enough (as seen in FIG. **2***a*) to fit in one or two conventional bus slots in a computer. In FIG. **2***a* x can be approximately between 10–22 mm. FIG. **3** shows a rear view of a computer **22** with a UPS card **10** according to one embodiment of the invention inserted in a PC slot therein.

Computer **22** also includes a power supply **32** as well as conventional printer **24** and RS232 **26** connectors.

The UPS card can be installed in any one of the free card slots in the computer. As shown in FIG. **3**, the AC mains line **28** is connected directly to the UPS card **10**, and a short jumper cable **30** connects the UPS card **10** to the computer power supply (SMPS) **32**. From the power supply **32**, a line **34** goes to the monitor (not shown). Thus, the current flows from the main line **28** into the UPS card **10**, and out of the UPS card **10** into the power supply **32** which powers both the computer and the screen. Alternatively, the UPS card **10** may be coupled internally to SMPS **32** so no jumper cord is required, as shown in FIG. **14**.

FIGS. **4** and **5** are respectively a schematic block diagram and electronic circuit of an internal UPS card in accordance with the invention. In FIG. **4** the parts A, B, C, D, E, F, G, I and J are shown as a block diagram and the operation is as follows:

The AC mains power goes (via a LITTELE sense PCB transformer—see FIG. **5**—T1) to a low voltage detector D and high voltage detector C. A reference voltage J, that can be adjustable, is supplied to the low and high voltage detectors D and C so that they can be set to the desired value. The reference voltage can be set by R**6** and R**7** multi-turn potentiometer (see FIG. **5**). The low and high voltage detection is performed by integrated circuits U1A–D, here shown as LM339 (QUAD OP AMP), that acts as a comparator. When the comparators D or C are active due to high voltage or low voltage AC mains (i.e., outage), the output of the relevant comparator goes high (U1C or U1D pin **13** or **14** in FIG. **5**) switching on the transistor Q**2** which becomes conductive and point CP (FIG. **5**) becomes ground potential. Relay K**1** then switches on and changes position so that COMP **1** and COMP **2** (output power to computer and screen) are now connected to INV**1** and INV**2** points (which will be discussed later) and disconnects from the mains power. The INV **1** and INV **2** points are connected to the output of the DC to DC/AC inverter G. The inverter G (as illustrated in detail in FIG. **6**) works with an SG3525 IC that acts as an oscillator that provides 25 kHz square wave pulses on its two output pins **14** and **11**. This IC can operate only if pin **10** is grounded.

Pin **10** of the SG3525, called INH (INH=inhibit) is connected to point "CP" (see FIGS. **5**C near the K**1** relay) so that it becomes active when AC mains power is out of the normal range (this is usually set for a 220V system to: low=196V, high=250V, but can be set to any wanted values). The inverter IC SG3525 starts to oscillate and generates a high DC voltage output with high power that enables the computer and screen to operate for several minutes from the battery power B.

As long as the SG3525 IC is not active, ("CP" is high, and no power is taken from battery B.) the battery is charged automatically by the automatic charger A receiving main line power via line **30**. The charger's transformer T**2** (see FIG. **7**) is a small size PCB mounting transformer that provides its output after rectification by two diodes **6A6** and 470UF capacitor, say 16.5 V. This is fed to a regulator, such as LM7808 that together with a Zener diode 5.IV gives a total output voltage of VLM7808+V zener=8+5.1=13.1 V

DC. The resistor 6.8 Ohm \3W is to limit the output current to the battery to, say, 150 to 200 mA. This voltage and current charge is a small, say, 12 V \2AH lead acid or other battery. The charger A stops automatically when the battery is fully charged (typically 13.1V) because the potential of the battery became equal to the output of the charger. The charger is always connected to the battery and, when AC mains exist, it charges the battery. When no AC mains exist, it does not affect the battery (discharge), so this unit A (detailed in FIG. **7**) is fully independent.

Alternatively charger A can receive power via line **35** from the PC bus slot (FIG. **4**), instead of from the mains line **30**, and step up the voltage received (5 V) to a higher voltage to charge the battery B. Other output voltages can be obtained by suitably varying the regulator 78XX and V zener.

Referring to FIG. **6** (the inverter G of FIG. **4**), the output of the SG3525 IC is fed to Mosfet power transistors Q**5** and Q**6**, each via two small transistors Q**1**, Q**2** to drive Q**5**, and Q**3**, Q**4** to drive Q**6**. These transistors are to charge\discharge the Mosfets for proper operation. The drain output of the Mosfets are connected to both sides of T**3** which is a ferrite low profile transformer (planar transformer for very low profile H=15 mm). One suitable transformer is model number 5557 manufactured by Payton Planar Magnetics Ltd., of Rishon LeZion. The centre of the primary of the transformer is connected to the battery. As long as the Mosfets Q**5** and Q**6** are not in oscillation, no power is taken from the battery. When SG3525 becomes active, Q**5** and Q**6** oscillate at high frequency, say 25 KHz (this may be another high frequency between 15 KHz to 200 KHz).

The planar ferrite transformer T**3** starts to operate in push-pull and provides in its secondary, a very high voltage AC=280 V \25 KHz with very high efficiency and low losses. The efficiency is better than 92%. The secondary of T**3** is fed to a reactifier bridge made up of 4 ultra fast diodes, and together with smoothing capacitor C**2** provides a high DC/AC voltage, high power output. This output (from G in FIG. **4**) is fed to the K**1** relay (also see FIGS. **5**C) to points INV**1** and INV**2**.

When the AC mains is low (outage) or high, as explained above, the inverter output is connected to the load (computer and screen). The switching time of the K**1** relay is 1 to 3 milli-seconds, so the computer power supply capacitors provide power during this dead time. This time is very short. The change over occurs when the mains power drops to, say, 196 V, so the computer SMPS capacitors are still charged. In this way the computer and screen will remain on and no data will be lost or damaged, because the K**1** relay disconnects the computer and screen from the mains when the mains is outside the desired range. The card also protects the hardware against spikes, surges, voltage and "jumps". Thus it proves a full protection solution.

All components are on a printed circuit board that is installed in one of the PC slots. This is made possible because the ferrite transformer has a low profile, i.e. is planar. (The planar transformer has a very low profile=15 mm. Other "regular" ferrites, or any other low profile planar transformer, will also be good). The transformer primary voltage=say, 2×9.8 V for a 12 V battery, the secondary voltage=say, 280 V (can be up to 320 V or so). This voltage is calculated: mains voltage×1.41=maximum of 310 V.

The UPS card has no power switch, so the user does not need to reach to the back of the computer to switch it on. This is also true for transportation of the computer. The only power on or off is the computer power switch.

With reference to FIG. **6**, the SG 3525 IC gets its power from a point called VSG. The VSG point is connected to K**2** relay point B' on FIG. **8**. This relay K**2**, which is indicated "I" on FIG. **4** and illustrated in detail in FIG. **8**, supplies the 12 V power to the IC SG3525 only when the computer is on. This works as follows: the card connected inside the computer receives from the computer board points B**1**, B**31** and B**3**, B**29** (see FIG. **9**) 5 V DC (B**1**, B**31**=GND and B**3**, B**29**=5 V DC) that activates the K**2** 6 V relay. Other types of connectors such as PCI can also be used to feed the voltage from the SMPS to the step-up inverter/charger (FIG. **10**). Points B' and A' of K**1** are connected when the PC is switched on (mains power on and normal). A' is connected to the positive terminal of the battery, so B' delivers the battery voltage to the SG3525 IC and enables it. Now, if a power outage occurs, SG3525 detects ground on pin **10** and starts to oscillate and that is only if VSG=9 to 12 V (see FIG. **6**). VSG is already at this voltage, as explained. Also, during switching from mains to inverter, the PC motherboard still provides the power to the K**2** relay (see FIG. **8**) so the inverter is still enabled. With the above conditions, the inverter oscillates to provide backup power to the computer and screen for several minutes. The user can now save the data on the hard disc or other data storage element, and turn off the computer. When the computer is turned off, the PC motherboard does not provide voltage to the inverter (to VSG—FIG. **6**) by the K**2** relay (FIG. **8**) and the inverter is turned off. To operate\enable the inverter again, the user must wait for power to reach the AC mains. If there is no AC mains at the beginning of operation, the UPS card will remain in the off position and can be transported without worry of accidental operation\battery discharge and electric shock. The card can operate only (as stated before) if installed inside the computer and the power switch of the computer is on and AC mains exist.

When the UPS card is off, no current at all flows from the battery. This is important, so that the battery will not discharge when not in use (on the shelf).

The card also has a low battery alarm (U1B in FIG. **5** and E in FIG. **4**) that activates an alarm buzzer **45**. Comparator U1B compares the battery voltage to reference voltage J in FIG. **4** and R**4** in FIG. **5**, and when the battery is lower than a pre-determined value (around, say, 10.5 v), the output of U1B becomes high and switches on the Q**1** transistor and activates the buzzer **45** to sound an alarm. This warns the user that he has only, say, one minute to shut-down, as will be described further on.

If the user has still not switched off the computer, the auto shut-down system (F in FIG. **4**) will do this. This system consists of a comparator U1A (FIG. **5**). When the battery goes low to, say, 10 V, the maximum permitted low level, U1A becomes high and via diodes D**4** and D**5** provides voltage to the comparators of the high\low detectors. This stimulates the return of AC mains and the output of U1C and U1D becomes low. This causes Q**2** to be open and the "CP" point goes high, causing the inverter to stop and the relay K**1** to release. In this way, no current is now drawn from the battery. This situation changes when the battery is charged again.

The card also has an input noise filter, so the computer is protected against RFI/EMI noise (FIG. **5** top left).

The UPS card also includes another RFI/EMI filter (CM**1**, CM**2**, LM**1** and LM**2**) with surge protection circuit shown in FIG. **13**. This circuit protects the computer from costly hardware damage due to inadvertent accession of high voltage spikes through the phone lines. Connectors RJ**1** **70** and RJ**2** **72** (seen in FIGS. **1** and **2***b*) are the input and output respectively, wherein the phone line is connected to input **70** and output **72** is connected to an external or internal modem/fax to protect the computer from RFI/EMI noises and spikes. A RV**1** varistor **80** and GT gas discharge tube **82** (FIG. **13**) clamp high voltage spikes in the telephone line.

The following are other differences between the UPS card of this invention and conventional UPS systems:

1. Conventional UPS devices that are capable of operating both computer and screen are separate boxes which are bulky and coupled to the computer as by cables. The UPS card of the present invention, due to its size and design, fits directly into one or two slots inside the computer itself.
2. Most importantly, the DC/DC inverter of this invention is very different from other DC/DC inverters because it provides high voltage power 280 V\120 W that can operate the screen together with the computer. Other UPS cards are unable to operate the screen, as well. The DC/DC converters used, convert to low DC levels to the PC motherboard. Usually they supply +5, −5, +12, −12 V DC and backup only to the computer, not to the screen.
3. In other type UPS cards, because the user cannot see the screen, the card comes together with software that has to be adjusted and suited to the user's software. Therefore installation is much more complicated.
4. The card of this invention also protects the computer hardware against abnormal power voltages (too high, spikes, drop out, etc.).
5. The card is protected against accidental operation. It cannot be operated until it is placed inside the computer.
6. The card does not have a power switch and it is "smart" to operate from the computer power switch, making it easier to use.
7. Because the card is a complete UPS in card size, it is very easy to install. Just plug it in the PC slot, close the computer cover and connect like any "regular" UPS= cable from mains to UPS card and cable from card to computer power supply. From PC power supply there is a connection in parallel to the screen so that preferably no connection to the screen is needed. However, additional output connectors can be provided on the card bracket for direct connection to the screen.
8. The efficiency of the converter is more than 92%, allowing it to use a small size/capacity battery.

Referring now to FIG. **9**, there is shown an alternative battery charger **50**. Charger **50** takes power from a PC bus extension slot **52** and uses the 5 V (or 12 V) that came to the PC bus from the PC power supply **54**. The Vcc voltage in FIG. **9** is taken from two ground points (pins B**1** and B**31**) and two positive points (pins B**3** and B**29**) for better current flow and to lower the current, and therefore the load, on each pin.

The input current can range from between about 0.5 and 1.2 A. Preferably, each pin provides half the current such as 0.25 A for a total of 0.6 A. This is fed to a step up converter **56**, the electronic circuit of which is shown in FIG. **10**. Step up converter **56** changes the 5V to voltage that suits the battery (usually 12 to 27 V) and charges the battery. The step up converter **56** has an output current limit resistor (RX) that limits the current charge according to the battery capacity in use (typically 200 mA for 2 AH battery capacity). RX is generally between 1 and 10 ohms, preferably 3 ohms for a battery capacity of 1.8 AH, which will deliver about 200 mA curent. The output is adjustable, as by a potentiometer, between about 5 V and about 24 V, typically preferably 18 V, to charge a battery of 14.4 V nominal voltage or 20 V to charge a battery of 16.8 V nominal voltage as in Ni—Cd sub C batteries.

The circuit shown in FIG. **10** is based on high frequency switching boost converter that switches current over coil (choke). The switching frequency can be in the range of about 20 KHz to about 200 KHz, typically 100 KHz. The integrated circuit that is used has a feedback loop so the output voltage is stable. A capacitor CX is provided to reduce ripple and to extend the time during which the 5 V remains after outage (i.e. during switching from mains to inverter). When the battery is fully charged, the potential of the battery is equal to the potential of the charger and the charge stops. (The current drops from 240 mA to 10 mA is measured with a 12 cell NiCad battery, of 14.4 V nominal voltage). The above makes the charger very small in size. This charger is shown as A in FIG. **4**.

Referring now to FIG. **11** there is shown a DC to AC step up inverter (G in FIG. **4**). This inverter includes Microchip (TM) microcontroller **58** (PIC 16C73 type) and analog to digital (A/D) converter **59**, regulator **62**, drive circuit with step up planar transformer **60**, filter/demo dulator **66** and feedback rectifier with filter **64**. Microcontroller **58** receives regulated 5 V from regulator **62** receiving power from the battery. When there is abnormal power the microcontroller **58**, which receives ground signal from point CP, generates output pulses A and B (that their timing is shown in FIG. **12**) to logic level Mosfet power transistors (not shown) in drive circuit **60**. Each frame/pulse train (A or B) is composed of frequency variable duty cycle pulses C. These pulses being amplified by the step up transformer are fed through the primary winding **61** of the transformer. The secondary winding **63** of the transformer is connected to filter/demodulator **66** which demodulate them to output an AC power. A feedback loop utilizes the output of the transformer from its auxilliary secondary winding **65** and feedback rectifier **64** to produce a correcting feedback pulse which is fed to microcontroller **58**, stabilizing the AC output by varying the duty cycle of all the pulses in the pulse trains A and B according to change in load.

It will be appreciated that the invention is not limited to what has been described hereinabove merely by way of example. Rather, the invention is limited solely by the claims which follow.

Software for Microcontroller (FIGS. **11, 12**)

```
;
; Timer 0 is used to generate 60 Hz clock
;
; Timer 2 is used to genertae 22 khz PWM clock
;
; ***************************************************************
;
        LIST    p=16C73         ; PIC16C73 is the target processor
#define option 1
f       equ     1               ; destination = register
w       equ     0               ; destination = w
tmr0    equ     1
status  equ     3
pc      equ     2
intcon  equ     .11
;option equ     1
trisa   equ     5
rp0     equ     5
trisb   equ     6
portb   equ     6
trisc   equ     7
portc   equ     7
gie     equ     7
t0if    equ     2
tmr21e  equ     1
tmr2if  equ     1
tmr2ie  equ     1
go      equ     2
pclath  equ     .10
pir1    equ     .12
pir2    equ     .13
pie1    equ     .12
pie2    equ     .13
tmr2    equ     .17
pr2     equ     .18
t2con   equ     .18
ccpr21  equ     .27
ccpr11  equ     .21
ccp2con equ     .29
adres   equ     .30
adcon0  equ     .31
adcon1  equ     .31
period  equ     .226            ; TIMER 2 226=22khz
dc      equ     .60             ; DUTY CYCLE
main0   equ     D'98'           ; TIMER 0 98=60.6hz
flag    equ     .51
dly     equ     .52
count   equ     .53
upd     equ     .54
result  equ     .55
temp    equ     .56
;
; ***************************************************************
;           Test Program
; ***************************************************************
;
begin
;       org     OH
;       goto    start
        org     140h
start
clrw
bcf     status, rp0     ; select bank 0
bsf     flag, 7         ; set flag.7 bit
movlw   main0           ; timer 0 is set
movwf   tmr0            ;       to produce 50hz
movlw   B'01100000'     ; disable
movwf   intcon          ;       all interrupts
clrf    tmr2            ; reset timer 2
movlw   B'00000100'     ; set t2con as
movwf   t2con           ; postscaler=1,
                        timer 2 on, prescaler=1
movlw   dc              ; set
movwf   ccpr21          ;    timer2 duty cycle midway
movlw   B'00001100'     ; set ccp2con as
movwf   ccp2con         ; PWM mode, 8 bit low resolution
bsf     status, rp0     ; select bank 1
bsf     piel, tmr2ie    ; enable TMR2 to PR2 interrupt bit
movlw   period          ; preset
movwf   pr2             ;       pr2
movlw   B'00000000'     ; put port
movwf   trisc           ;       'C' output mode
movwf   trisb           ;       'B' in output mode
movlw   B'11111111'     ; put port
movwf   trisa           ;       'A' in input mode
movlw   B'10000110'     ; psa=128, internal clock
        movwf   option  ;
        call    initad  ; initialize A2D
        movlw   B'11111111'     ; set rgister
        movwf   dly     ; dly=255
dd      decfsz  dly, f  ; loop
        goto    dd      ;
        bsf     adcon0, go      ; start A2D coversion
        movlw   B'11111111'     ; more delay
        movwf   dly     ; set register dly=255
ee      decfsz  dly, f  ; loop
        goto    ee      ;
        bsf     intcon, gie     ; enables timer 0 + 2 interrupts
loop    nop
        nop
        nop
```

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```
        goto    loop
        org     OH
        goto    start
;
;       start of interrupt routine
;
        org     0004H
        bcf     status, rp0     ; select bank 0
        btfss   intcon, tmr2if  ; timer 2 interrupt ?
        goto    xx
        btfsc   flag, 6         ; 1=UP or 0=DOWN
        incf    upd             ; increment upd
        btfss   flag, 6         ; 1=UP or 0=DOWN
        decf    upd             ; decrement upd
        movf    upd, w
        movwf   temp
        rrf     temp, f
        rrf     temp, w
        andlw   0x1f
        iorwf   result, w
        call    table
        movwf   ccpr21
        bcf     pirl, tmr2if    ; clear timer 2 interrupt flag
xx      btfss   intcon, t0if    ; if timer 0 overflow
        retfie                  ; else exit
        movlw   main0
        movwf   tmr0
        bcf     intcon, t0if    ; clear timer 0 overflow flag
        incf    count, f        ; increment register COUNT
        btfsc   count, 0        ; if count.0=1 then
                                flag.6=0 -> DOWN
        bcf     flag, 6         ;
        btfsc   count, 0        ; continue if count=even
        retfie                  ; exit
        bsf     flag, 6         ; if count.0=0 then flag.6=1 -> up
        movlw   .255            ; toggle port B
        xorwf   portb, f        ;
        clrf    upd             ; clear up-down
;       movf    adres, w
        movlw   0x0e0               ; just for debugging
        andlw   0xe0
        movwf   result
        btfsc   adcon0, go      ; see if a2d is finished
        retfie                  ; exit
;       movf    adres, w
        movlw   0x0e0               ; just for debugging
        andlw.  0xe0
        movwf   result
        bsf     adcon0, go      ; start a2d
        retfie                  ; exit
;
; init A2D
;
; initad
        bsf     status, rp0     ; select bank 1
        movlw   B'00000001'     ; ra3=ref, all
                                A inputs analog
        movwf   adcon1          ;
        bcf     status, rp0     ; select bank 0
        movlw   B'10000001'     ; adon is on,
                                channel 0,
                                osc=32
        movwf   adcon0
        return
        org     4.00h
table
        addwf   pc              ; w=offset
        retlw   .230            ; 0         0x
        retlw   .225            ; 1
        retlw   .220            ; 2
        retlw   .215            ; 3
        retlw   .210            ; 4
        retlw   .205            ; 5
        retlw   .200            ; 6
        retlw   .195            ; 7
        retlw   .190            ; 8
        retlw   .185            ; 9
        retlw   .180            ; 10
        retlw   .175            ; 11
```

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```
        retlw   .170            ; 12
        retlw   .165            ; 13
        retlw   .160            ; 14
        retlw   .155            ; 15
        retlw   .150            ; 16
        retlw   .145            ; 17
        retlw   .140            ; 18
        retlw   .135            ; 19
        retlw   .130            ; 20
        retlw   .125            ; 21
        retlw   .120            ; 22
        retlw   .115            ; 23
        retlw   .110            ; 24
        retlw   .105            ; 25
        retlw   .95             ; 26
        retlw   .90             ; 27
        retlw   .85             ; 28
        retlw   .80             ; 29
        retlw   .75             ; 30
        retlw   .70             ; 31
        retlw   .130            ; 32        20x
        retlw   .125            ; 33
        retlw   .120            ; 34
        retlw   .115            ; 35
        retlw   .181            ; 112
        retlw   .181            ; 113
        retlw   .179            ; 114
        retlw   .179            ; 115
        retlw   .177            ; 116
        retlw   .177            ; 117
        retlw   .175            ; 118
        retlw   .175            ; 119
        retlw   .173            ; 120
        retlw   .173            ; 121
        retlw   .171            ; 122
        retlw   .171            ; 123
        retlw   .169            ; 124
        retlw   .169            ; 125
        retlw   .165            ; 126
        retlw   .165            ; 127
        retlw   .124            ; 128       80x
        retlw   .124            ; 129
        retlw   .124            ; 130
        retlw   .121            ; 131
        retlw   .121            ; 132
        retlw   .121            ; 133
        retlw   .121            ; 134
        retlw   .119            ; 135
        retlw   .119            ; 136
        retlw   .119            ; 137
        retlw   .116            ; 138
        retlw   .116            ; 139
        retlw   .116            ; 140
        retlw   .113            ; 141
        retlw   .113            ; 142
        retlw   .113            ; 143
        retlw   .110            ; 144
        retlw   .110            ; 145
        retlw   .110            ; 146
        retlw   .107            ; 147
        retlw   .107            ; 148
        retlw   .107            ; 149
        retlw   .104            ; 150
        retlw   .104            ; 151
        retlw   .104            ; 152
        retlw   .101            ; 153
        retlw   .101            ; 154
        retlw   .101            ; 155
        retlw   .98             ; 156
        retlw   .98             ; 157
        retlw   .98             ; 158
        retlw   .98             ; 159
        retlw   .130            ; 160       0a0x
        retlw   .130            ; 161
        retlw   .130            ; 162
        retlw   .125            ; 163
        retlw   .125            ; 164
        retlw   .125            ; 165
        retlw   .120            ; 166
```

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retlw   .120    ; 167
retlw   .120    ; 168
retlw   .115    ; 169
retlw   .115    ; 170
retlw   .115    ; 171
retlw   .110    ; 172
retlw   .110    ; 173
retlw   .110    ; 174
retlw   .105    ; 175
retlw   .105    ; 176
retlw   .105    ; 177
retlw   .100    ; 178
retlw   .100    ; 179
retlw   .100    ; 180
retlw   .95     ; 181
retlw   .95     ; 182
retlw   .95     ; 183
retlw   .90     ; 184
retlw   .90     ; 185
retlw   .90     ; 186
retlw   .85     ; 187
retlw   .85     ; 188
retlw   .85     ; 189
retlw   .80     ; 190
retlw   .80     ; 191
retlw   .200    ; 192   0c0x
retlw   .200    ; 193
retlw   .200    ; 194
retlw   .200    ; 195
retlw   .200    ; 196
retlw   .200    ; 197
retlw   .190    ; 198
retlw   .190    ; 199
retlw   .190    ; 200
retlw   .190    ; 201
retlw   .190    ; 202
retlw   .190    ; 203
retlw   .180    ; 204
retlw   .180    ; 205
retlw   .180    ; 206
retlw   .180    ; 207
retlw   .180    ; 208
retlw   .180    ; 209
retlw   .170    ; 210
retlw   .170    ; 211
retlw   .170    ; 212
retlw   .170    ; 213
retlw   .170    ; 214
retlw   .170    ; 215
retlw   .160    ; 216
retlw   .160    ; 217
retlw   .160    ; 218
retlw   .160    ; 219
retlw   .160    ; 220
retlw   .160    ; 221
retlw   .160    ; 222
retlw   .160    ; 223
retlw   .130    ; 224   e0x
retlw   .125    ; 225
retlw   .120    ; 226
retlw   .115    ; 227
retlw   .110    ; 228
retlw   .105    ; 229
retlw   .100    ; 230
retlw   .95     ; 231
retlw   .90     ; 232
retlw   .85     ; 233
retlw   .80     ; 234
retlw   .75     ; 235
retlw   .70     ; 236
retlw   .65     ; 237
retlw   .60     ; 238
retlw   .55     ; 239
retlw   .50     ; 240
retlw   .45     ; 241
retlw   .40     ; 242
retlw   .35     ; 243
retlw   .30     ; 244
retlw   .25     ; 245
```

-continued

```
retlw   .20     ; 246
retlw   .15     ; 247
retlw   .10     ; 248
retlw   .5      ; 249
retlw   .0      ; 250
retlw   .255    ; 251
retlw   .250    ; 252
retlw   .245    ; 253
retlw   .240    ; 254
retlw   .235    ; 255
org     700h
goto    begin
retlw   .110    ; 36
retlw   .105    ; 37
retlw   .100    ; 38
retlw   .95     ; 39
retlw   .90     ; 40
retlw   .85     ; 41
retlw   .80     ; 42
retlw   .75     ; 43
retlw   .70     ; 44
retlw   .65     ; 45
retlw   .60     ; 46
retlw   .55     ; 47
retlw   .50     ; 48
retlw   .45     ; 49
retlw   .40     ; 50
retlw   .35     ; 51
retlw   .30     ; 52
retlw   .25     ; 53
retlw   .20     ; 54
retlw   .15     ; 55
retlw   .10     ; 56
retlw   .5      ; 57
retlw   .0      ; 58
retlw   .255    ; 59
retlw   .250    ; 60
retlw   .245    ; 61
retlw   .240    ; 62
retlw   .235    ; 63
retlw   .230    ; 64    40x
retlw   .220    ; 65
retlw   .210    ; 66
retlw   .200    ; 67
retlw   .190    ; 68
retlw   .180    ; 69
retlw   .170    ; 70
retlw   .160    ; 71
retlw   .150    ; 72
retlw   .140    ; 73
retlw   .130    ; 74
retlw   .120    ; 75
retlw   .110    ; 76
retlw   .100    ; 77
retlw   .90     ; 78
retlw   .80     ; 79
retlw   .70     ; 80
retlw   .60     ; 81
retlw   .50     ; 82
retlw   .40     ; 83
retlw   .20     ; 84
retlw   .10     ; 85
retlw   .0      ; 86
retlw   .245    ; 87
retlw   .235    ; 88
retlw   .235    ; 89
retlw   .235    ; 90
retlw   .235    ; 91
retlw   .235    ; 92
retlw   .235    ; 93
retlw   .235    ; 94
retlw   .235    ; 95
retlw   .197    ; 96    60x
retlw   .197    ; 97
retlw   .195    ; 98
retlw   .195    ; 99
retlw   .193    ; 100
retlw   .193    ; 101
retlw   .191    ; 102
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-continued

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        retlw   .191        ; 103
        retlw   .189        ; 104
        retlw   .189        ; 105
        retlw   .187        ; 106
        retlw   .187        ; 107
        retlw   .185        ; 108
        retlw   .185        ; 109
        retlw   .183        ; 110
        retlw   .183        ; 111
        org     900h
        goto    begin
end
```

What is claimed is:

1. An off-line uninterrupted power supply (UPS) for a computer having a data storage element and an associated monitor, the computer operating on power supplied by an internal switch mode power supply (SMPS) system receiving line power, characterized in that said UPS consists of an internal device for installation inside the computer and said internal device mains AC power and protection to the computer and to the monitor from power abnormalities and noises and in the event of a line failure provides AC power produced by the off-line UPS internal circuits to the computer and monitor.

2. A UPS as in claim **1** characterized in that the UPS device is an internal card.

3. A UPS according to claim **2** sized to permit it to fit into a single bus slot of a computer.

4. A UPS card according to claim **2**, wherein a charger receives low voltage from a computer bus slot via two or more bus pins for each of ground and +V respectively, thereby reducing current flow through each pin and relevant conductors on a mother board.

5. A UPS card according to claim **2** comprising as a battery charger a step-up inverter/charger receiving a low voltage from a bus slot and that steps up said low voltage to a higher voltage to charge a higher voltage battery.

6. A UPS card as in claim **5** wherein the low voltage received by the step-up inverter/charger is between 3–12 volts and the higher voltage in between 5–27 volts.

7. A UPS for a computer, as in claim **1** characterized in that the UPS is installed in the switch mode power supply (SMPS) of the computer.

8. A UPS according to claim **1**, comprising a planar transformer, high frequency oscillator, power transistors, rectifier and smoothing capacitor.

9. A UPS according to claim **8**, wherein said planar transformer is a ferrite step-up transformer.

10. A UPS according to claim **1** and further comprising means for downloading communication software.

11. A UPS as in claim **1**, further comprising telephone line connectors and protection of the computer against RFI/EMI noises and spikes coming from a telephone line.

12. A UPS as in claim **11**, wherein a UPS card is coupled to the telephone line and to a fax/modem card via a short jumper cable.

13. A computer system comprising a computer and screen and internal UPS in accordance with claim **1**.

14. A computer system as claimed in claim **13**, wherein a UPS card is coupled to an AC mains line, and said UPS card is also coupled to an internal power supply of said computer via a short jumper cable.

15. An off-line internal UPS providing an internal DC power output of 200–320 volts and AC power output of 220/110 V 50/60 Hz respectively, comprising a printed circuit board, a battery, an automatic battery charger, a DC to DC and a DC to AC high voltage inverter that oscillates in the range of 15 to 200 KHz, low and high voltage detectors and a change over switch/relay for providing mains AC power and AC power internally produced by said off-line UPS, all mounted on said board, said internal off-line UPS being activated by the computer on/off switch.

16. An internal UPS as in claim **15**, activated by a separate on/off switch.

17. A UPS according to claim **15** and further comprising low battery alarm means, and automatic shut-off means operative when a voltage in the battery falls below a pre-determined acceptable level.

18. A UPS according to claim **15**, providing AC power output of 220/110 V 50/60 Hz respectively, wherein the DC and AC high voltage inverter comprises a micro-controller and an A/D converter.

19. An off-line uninterruptible power supply (UPS) for a personal computer, which receives line power and has a video display monitor coupled thereto, the computer having an internal bus and a plurality of mutually parallel slots on the bus with a predetermined spacing therebetween for insertion of extension cards thereinto, the UPS comprising:

a printed circuit card having circuit components mounted thereon which is inserted into one of the plurality of slots, such that a width of the printed circuit card including the circuit components is generally equal to or less than the predetermined spacing of the slots, and which provides mains AC power to the personal computer and the display monitor and in the event of a failure of the line power provides AC power internally produced by the off-line UPS internal circuits.

20. A UPS according to claim **19**, wherein the circuit components mounted on the printed circuit card include one or more batteries.

21. A UPS according to claim **19**, wherein the circuit components mounted on the printed circuit card include a planar transformer.

22. A UPS according to claim **19**, wherein the printed circuit card is actuated responsive to a bus voltage received via the slot into which it is inserted, such that the UPS is inactive when removed from the slot.

23. A UPS according to claim **19**, wherein the bus comprises an industry-standard personal computer bus.

24. A UPS according to claim **19**, wherein the circuit components mounted on the printed circuit card include input and output connectors for the lines power, wherein the personal computer and the monitor receive power from the lines power output connector.

25. A UPS according to claim **24**, wherein the input and output connectors are accessible at a panel of the personal computer for attachment of power cables thereto.

26. An off-line uninterruptible power supply (UPS) for a personal computer, which operates on line power, the computer having an internal bus and a plurality of mutually parallel slots on the bus for insertion of extention cards thereinto, the UPS comprising:

a printed circuit card having circuit components mounted thereon which is inserted into at least one of the plurality of slots, which card provides main AC power to the personal computer and in the event of a failure of the line power provides AC power internally produced by the off-line UPS internal circuits, the components including a line power input connector accessible at a panel of the personal computer, through which connector the off-line UPS and the computer receive the line power.

27. A UPS according to claim 26, wherein a video display monitor is coupled to the computer, and wherein the components on the card include a lines power output connector from which the computer and the display receive the lines power.

28. A UPS according to claim 26, wherein the plurality of mutually parallel slots have a predetermined spacing therebetween, and wherein the input connector has a width in a direction perpendicular to a plane of the card that is substantially less than a predetermined spacing.

29. A UPS according to claim 28, wherein the bus comprises an industry-standard personal computer bus.

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